

N-ACYLATED-3-(BENZOYL)-PYRROLIDINES AS 11-BETA-HSD1 INHIBITORS USEFUL FOR THE TREATMENT OF METABOLIC DISORDERS.

This invention relates to chemical compounds, or pharmaceutically acceptable salts thereof. These compounds possess human 11- $\beta$ -hydroxysteroid dehydrogenase type 1 enzyme  
5 (11 $\beta$ HSD1) inhibitory activity and accordingly have value in the treatment of disease states including metabolic syndrome and are useful in methods of treatment of a warm-blooded animal, such as man. The invention also relates to processes for the manufacture of said compounds, to pharmaceutical compositions containing them and to their use in the manufacture of medicaments to inhibit 11 $\beta$ HSD1 in a warm-blooded animal, such as man.

10       Glucocorticoids (cortisol in man, corticosterone in rodents) are counter regulatory hormones i.e. they oppose the actions of insulin (Dallman MF, Strack AM, Akana SF et al. 1993; Front Neuroendocrinol 14, 303-347). They regulate the expression of hepatic enzymes involved in gluconeogenesis and increase substrate supply by releasing glycerol from adipose tissue (increased lipolysis) and amino acids from muscle (decreased protein synthesis and  
15 increased protein degradation). Glucocorticoids are also important in the differentiation of pre-adipocytes into mature adipocytes which are able to store triglycerides (Bujalska IJ et al. 1999; Endocrinology 140, 3188-3196). This may be critical in disease states where glucocorticoids induced by "stress" are associated with central obesity which itself is a strong risk factor for type 2 diabetes, hypertension and cardiovascular disease (Bjorntorp P &  
20 Rosmond R 2000; Int. J. Obesity 24, S80-S85)

It is now well established that glucocorticoid activity is controlled not simply by secretion of cortisol but also at the tissue level by intracellular interconversion of active cortisol and inactive cortisone by the 11-beta hydroxysteroid dehydrogenases, 11 $\beta$ HSD1 (which activates cortisone) and 11 $\beta$ HSD2 (which inactivates cortisol) (Sandeep TC & Walker  
25 BR 2001 Trends in Endocrinol & Metab. 12, 446-453). That this mechanism may be important in man was initially shown using carbenoxolone (an anti-ulcer drug which inhibits both 11 $\beta$ HSD1 and 2) treatment which (Walker BR et al. 1995; J. Clin. Endocrinol. Metab. 80, 3155-3159) leads to increased insulin sensitivity indicating that 11 $\beta$ HSD1 may well be regulating the effects of insulin by decreasing tissue levels of active glucocorticoids (Walker  
30 BR et al. 1995; J. Clin. Endocrinol. Metab. 80, 3155-3159).

Clinically, Cushing's syndrome is associated with cortisol excess which in turn is associated with glucose intolerance, central obesity (caused by stimulation of pre-adipocyte differentiation in this depot), dyslipidaemia and hypertension. Cushing's syndrome shows a

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number of clear parallels with metabolic syndrome. Even though the metabolic syndrome is not generally associated with excess circulating cortisol levels (Jessop DS et al. 2001; J. Clin. Endocrinol. Metab. 86, 4109-4114) abnormally high 11 $\beta$ HSD1 activity within tissues would be expected to have the same effect. In obese men it was shown that despite having similar or  
5 lower plasma cortisol levels than lean controls, 11 $\beta$ HSD1 activity in subcutaneous fat was greatly enhanced (Rask E et al. 2001; J. Clin. Endocrinol. Metab. 1418-1421). Furthermore, the central fat, associated with the metabolic syndrome expresses much higher levels of 11 $\beta$ HSD1 activity than subcutaneous fat (Bujalska IJ et al. 1997; Lancet 349, 1210-1213). Thus there appears to be a link between glucocorticoids, 11 $\beta$ HSD1 and the metabolic  
10 syndrome.

11 $\beta$ HSD1 knock-out mice show attenuated glucocorticoid-induced activation of gluconeogenic enzymes in response to fasting and lower plasma glucose levels in response to stress or obesity (Kotelevtsev Y et al. 1997; Proc. Natl. Acad. Sci USA 94, 14924-14929) indicating the utility of inhibition of 11 $\beta$ HSD1 in lowering of plasma glucose and hepatic  
15 glucose output in type 2 diabetes. Furthermore, these mice express an anti-atherogenic lipoprotein profile, having low triglycerides, increased HDL cholesterol and increased apo-lipoprotein AI levels. (Morton NM et al. 2001; J. Biol. Chem. 276, 41293-41300). This phenotype is due to an increased hepatic expression of enzymes of fat catabolism and PPAR $\alpha$ . Again this indicates the utility of 11 $\beta$ HSD1 inhibition in treatment of the  
20 dyslipidaemia of the metabolic syndrome.

The most convincing demonstration of a link between the metabolic syndrome and 11 $\beta$ HSD1 comes from recent studies of transgenic mice over-expressing 11 $\beta$ HSD1 (Masuzaki H et al. 2001; Science 294, 2166-2170). When expressed under the control of an adipose specific promoter, 11 $\beta$ HSD1 transgenic mice have high adipose levels of  
25 corticosterone, central obesity, insulin resistant diabetes, hyperlipidaemia and hyperphagia. Most importantly, the increased levels of 11 $\beta$ HSD1 activity in the fat of these mice are similar to those seen in obese subjects. Hepatic 11 $\beta$ HSD1 activity and plasma corticosterone levels were normal, however, hepatic portal vein levels of corticosterone were increased 3 fold and it is thought that this is the cause of the metabolic effects in liver.

30 Overall it is now clear that the complete metabolic syndrome can be mimicked in mice simply by overexpressing 11 $\beta$ HSD1 in fat alone at levels similar to those in obese man.

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11 $\beta$ HSD1 tissue distribution is widespread and overlapping with that of the glucocorticoid receptor. Thus, 11 $\beta$ HSD1 inhibition could potentially oppose the effects of glucocorticoids in a number of physiological/pathological roles. 11 $\beta$ HSD1 is present in human skeletal muscle and glucocorticoid opposition to the anabolic effects of insulin on protein turnover and glucose metabolism are well documented (Whorwood CB et al. 2001; J. Clin. Endocrinol. Metab. 86, 2296-2308). Skeletal muscle must therefore be an important target for 11 $\beta$ HSD1 based therapy.

Glucocorticoids also decrease insulin secretion and this could exacerbate the effects of glucocorticoid induced insulin resistance. Pancreatic islets express 11 $\beta$ HSD1 and carbenoxolone can inhibit the effects of 11-dehydrocorticosterone on insulin release (Davani B et al. 2000; J. Biol. Chem. 275, 34841-34844). Thus in treatment of diabetes 11 $\beta$ HSD1 inhibitors may not only act at the tissue level on insulin resistance but also increase insulin secretion itself.

Skeletal development and bone function is also regulated by glucocorticoid action. 11 $\beta$ HSD1 is present in human bone osteoclasts and osteoblasts and treatment of healthy volunteers with carbenoxolone showed a decrease in bone resorption markers with no change in bone formation markers (Cooper MS et al 2000; Bone 27, 375-381). Inhibition of 11 $\beta$ HSD1 activity in bone could be used as a protective mechanism in treatment of osteoporosis.

Glucocorticoids may also be involved in diseases of the eye such as glaucoma. 11 $\beta$ HSD1 has been shown to affect intraocular pressure in man and inhibition of 11 $\beta$ HSD1 may be expected to alleviate the increased intraocular pressure associated with glaucoma (Rauz S et al. 2001; Investigative Ophthalmology & Visual Science 42, 2037-2042).

There appears to be a convincing link between 11 $\beta$ HSD1 and the metabolic syndrome both in rodents and in humans. Evidence suggests that a drug which specifically inhibits 11 $\beta$ HSD1 in type 2 obese diabetic patients will lower blood glucose by reducing hepatic gluconeogenesis, reduce central obesity, improve the atherogenic lipoprotein phenotype, lower blood pressure and reduce insulin resistance. Insulin effects in muscle will be enhanced and insulin secretion from the beta cells of the islet may also be increased.

Currently there are two main recognised definitions of metabolic syndrome.

1) The Adult Treatment Panel (ATP III 2001 JMA) definition of metabolic syndrome indicates that it is present if the patient has three or more of the following symptoms:

- Waist measuring at least 40 inches (102 cm) for men, 35 inches (88 cm) for women;

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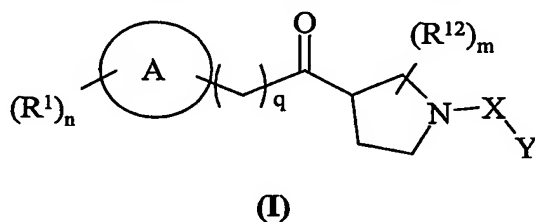
- Serum triglyceride levels of at least 150 mg/dl (1.69 mmol/l);
- HDL cholesterol levels of less than 40 mg/dl (1.04 mmol/l) in men, less than 50 mg/dl (1.29 mmol/l) in women;
- Blood pressure of at least 135/80 mm Hg; and / or
- 5 ➤ Blood sugar (serum glucose) of at least 110 mg/dl (6.1 mmol/l).

2) The WHO consultation has recommended the following definition which does not imply causal relationships and is suggested as a working definition to be improved upon in due course:

- The patient has at least one of the following conditions: glucose intolerance, impaired
- 10 glucose tolerance (IGT) or diabetes mellitus and/or insulin resistance; together with two or more of the following:
- Raised Arterial Pressure;
- Raised plasma triglycerides
- Central Obesity
- 15 ➤ Microalbuminuria

We have found that the compounds defined in the present invention, or a pharmaceutically acceptable salt thereof, are effective 11 $\beta$ HSD1 inhibitors, and accordingly have value in the treatment of disease states associated with metabolic syndrome.

Accordingly, there is provided the use of a compound of formula (I):



wherein:

**Ring A** is selected from carbocyclyl or heterocyclyl; wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from

25  $R^9$ ;

$R^1$  is a substituent on carbon and is selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl,  $C_{1-4}$ alkyl,  $C_{2-4}$ alkenyl,  $C_{2-4}$ alkynyl,  $C_{1-4}$ alkoxy,  $C_{1-4}$ alkanoyl,  $C_{1-4}$ alkanoyloxy,  $N$ -( $C_{1-4}$ alkyl)amino,  $N,N$ -( $C_{1-4}$ alkyl) $_2$ amino,  $C_{1-4}$ alkanoylamino,  $N$ -( $C_{1-4}$ alkyl)carbamoyl,  $N,N$ -( $C_{1-4}$ alkyl) $_2$ carbamoyl,  $C_{1-4}$ alkylS(O) $_a$

30 wherein a is 0 to 2,  $C_{1-4}$ alkoxycarbonyl,  $N$ -( $C_{1-4}$ alkyl)sulphamoyl,  $N,N$ -( $C_{1-4}$ alkyl) $_2$ sulphamoyl,  $C_{1-4}$ alkylsulphonylamino, carbocyclyl, heterocyclyl,

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carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>1</sup> may be optionally substituted on carbon by one or more groups selected from R<sup>3</sup>; and wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>4</sup>;

5        **n** is 0-5; wherein the values of R<sup>1</sup> may be the same or different;

**X** is a direct bond, -C(O)-, -S(O)<sub>2</sub>-, -C(O)NR<sup>11</sup>-, -C(S)NR<sup>11</sup>-, -C(O)O-, -C(=NR<sup>11</sup>)- or -CH<sub>2</sub>-; wherein R<sup>11</sup> is selected from hydrogen, C<sub>1-4</sub>alkyl, carbocyclyl and heterocyclyl;

**Y** is hydrogen, C<sub>1-6</sub>alkyl, C<sub>2-6</sub>alkenyl, C<sub>2-6</sub>alkynyl, carbocyclyl or heterocyclyl; wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>; wherein if said

10 heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>5</sup>;

**R<sup>2</sup>** is a substituent on carbon and is selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl, trifluoromethyl, trifluoromethoxy, C<sub>1-4</sub>alkyl, C<sub>2-4</sub>alkenyl, C<sub>2-4</sub>alkynyl, C<sub>1-4</sub>alkoxy, C<sub>1-4</sub>alkanoyl, C<sub>1-4</sub>alkanoyloxy, *N*-(C<sub>1-4</sub>alkyl)amino,

15 *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>amino, C<sub>1-4</sub>alkanoylamino, *N*-(C<sub>1-4</sub>alkyl)carbamoyl,

*N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl, C<sub>1-4</sub>alkylS(O)<sub>a</sub> wherein a is 0 to 2, C<sub>1-4</sub>alkoxycarbonyl,

C<sub>1-4</sub>alkoxycarbonylamino, C<sub>1-4</sub>alkoxycarbonyl-*N*-(C<sub>1-4</sub>alkyl)amino, *N*-(C<sub>1-4</sub>alkyl)sulphamoyl,

*N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl, C<sub>1-4</sub>alkylsulphonylamino, aminothiocabonylthio,

*N*-(C<sub>1-4</sub>alkyl)aminothiocabonylthio, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>aminothiocabonylthio, carbocyclyl,

20 heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>2</sup> may be optionally substituted on carbon by one or more groups selected from R<sup>6</sup>; and wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>7</sup>;

**R<sup>3</sup>** and **R<sup>6</sup>** are independently selected from halo, nitro, cyano, hydroxy, amino,

25 carboxy, carbamoyl, mercapto, sulphamoyl, trifluoromethyl, trifluoromethoxy, C<sub>1-4</sub>alkyl,

C<sub>2-4</sub>alkenyl, C<sub>2-4</sub>alkynyl, C<sub>1-4</sub>alkoxy, C<sub>1-4</sub>alkanoyl, C<sub>1-4</sub>alkanoyloxy, *N*-(C<sub>1-4</sub>alkyl)amino,

*N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>amino, C<sub>1-4</sub>alkanoylamino, *N*-(C<sub>1-4</sub>alkyl)carbamoyl,

*N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl, C<sub>1-4</sub>alkylS(O)<sub>a</sub> wherein a is 0 to 2, C<sub>1-4</sub>alkoxycarbonyl,

C<sub>1-4</sub>alkoxycarbonylamino, C<sub>1-4</sub>alkoxycarbonyl-*N*-(C<sub>1-4</sub>alkyl)amino, *N*-(C<sub>1-4</sub>alkyl)sulphamoyl,

30 *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl, C<sub>1-4</sub>alkylsulphonylamino, carbocyclyl, heterocyclyl,

carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>3</sup> and R<sup>6</sup> may be independently optionally substituted on carbon by one or more R<sup>8</sup>; and wherein if said

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heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from  $R^{13}$ ;

$R^4$ ,  $R^5$ ,  $R^7$ ,  $R^9$  and  $R^{13}$  are independently selected from  $C_{1-4}$ alkyl,  $C_{1-4}$ alkanoyl,  $C_{1-4}$ alkylsulphonyl,  $C_{1-4}$ alkoxycarbonyl, carbamoyl,  $N$ -( $C_{1-4}$ alkyl)carbamoyl,

5  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>carbamoyl, benzyl, benzyloxycarbonyl, benzoyl and phenylsulphonyl;

$R^8$  is selected from halo, nitro, cyano, hydroxy, trifluoromethoxy, trifluoromethyl, amino, carboxy, carbamoyl, mercapto, sulphamoyl, methyl, ethyl, methoxy, ethoxy, acetyl, acetoxymethyl, methylamino, ethylamino, dimethylamino, diethylamino,  $N$ -methyl- $N$ -ethylamino, acetylamino,  $N$ -methylcarbamoyl,  $N$ -ethylcarbamoyl,  $N,N$ -dimethylcarbamoyl,

10  $N,N$ -diethylcarbamoyl,  $N$ -methyl- $N$ -ethylcarbamoyl, methylthio, ethylthio, methylsulphinyl, ethylsulphinyl, mesyl, ethylsulphonyl, methoxycarbonyl, ethoxycarbonyl,  $N$ -methylsulphamoyl,  $N$ -ethylsulphamoyl,  $N,N$ -dimethylsulphamoyl,  $N,N$ -diethylsulphamoyl or  $N$ -methyl- $N$ -ethylsulphamoyl;

$Z$  is -S(O)<sub>a</sub>-, -O-, -NR<sup>10</sup>-, -C(O)-, -C(O)NR<sup>10</sup>-, -NR<sup>10</sup>C(O)-, -OC(O)NR<sup>10</sup>- or  
15 -SO<sub>2</sub>NR<sup>10</sup>-; wherein  $a$  is 0 to 2; wherein  $R^{10}$  is selected from hydrogen and  $C_{1-4}$ alkyl;

$R^{12}$  is hydroxy, methyl, ethyl, propyl or trifluoromethyl;

$m$  is 0 or 1;

$q$  is 0 or 1;

or a pharmaceutically acceptable salt thereof;

20 in the manufacture of a medicament for use in the inhibition of 11 $\beta$ HSD1.

In another aspect, there is provided the use of a compound of formula (I):  
wherein:

**Ring A** is selected from carbocyclyl or heterocyclyl; wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from

25  $R^9$ ;

$R^1$  is a substituent on carbon and is selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl,  $C_{1-4}$ alkyl,  $C_{2-4}$ alkenyl,  $C_{2-4}$ alkynyl,  $C_{1-4}$ alkoxy,  $C_{1-4}$ alkanoyl,  $C_{1-4}$ alkanoyloxy,  $N$ -( $C_{1-4}$ alkyl)amino,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>amino,  $C_{1-4}$ alkanoylamino,  $N$ -( $C_{1-4}$ alkyl)carbamoyl,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>carbamoyl,  $C_{1-4}$ alkylS(O)<sub>a</sub>

30 wherein  $a$  is 0 to 2,  $C_{1-4}$ alkoxycarbonyl,  $N$ -( $C_{1-4}$ alkyl)sulphamoyl,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>sulphamoyl,  $C_{1-4}$ alkylsulphonylamino, carbocyclyl, heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein  $R^1$  may be optionally substituted on carbon by one or more groups selected from  $R^3$ ; and wherein if said

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heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>4</sup>;

n is 0-5; wherein the values of R<sup>1</sup> may be the same or different;

X is a direct bond, -C(O)-, -S(O)<sub>2</sub>-, -C(O)NR<sup>11</sup>-, -C(S)NR<sup>11</sup>-, -C(O)O-, -C(=NR<sup>11</sup>)- or  
 5 -CH<sub>2</sub>-; wherein R<sup>11</sup> is selected from hydrogen, C<sub>1-4</sub>alkyl, carbocyclyl and heterocyclyl;

Y is hydrogen, C<sub>1-6</sub>alkyl, C<sub>2-6</sub>alkenyl, C<sub>2-6</sub>alkynyl, carbocyclyl or heterocyclyl;

wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>; wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>5</sup>;

10 R<sup>2</sup> is a substituent on carbon and is selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl, trifluoromethyl, trifluoromethoxy, C<sub>1-4</sub>alkyl, C<sub>2-4</sub>alkenyl, C<sub>2-4</sub>alkynyl, C<sub>1-4</sub>alkoxy, C<sub>1-4</sub>alkanoyl, C<sub>1-4</sub>alkanoyloxy, N-(C<sub>1-4</sub>alkyl)amino, N,N-(C<sub>1-4</sub>alkyl)<sub>2</sub>amino, C<sub>1-4</sub>alkanoylamino, N-(C<sub>1-4</sub>alkyl)carbamoyl, N,N-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl, C<sub>1-4</sub>alkylS(O)<sub>a</sub> wherein a is 0 to 2, C<sub>1-4</sub>alkoxycarbonyl,  
 15 C<sub>1-4</sub>alkoxycarbonylamino, C<sub>1-4</sub>alkoxycarbonyl-N-(C<sub>1-4</sub>alkyl)amino, N-(C<sub>1-4</sub>alkyl)sulphamoyl, N,N-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl, C<sub>1-4</sub>alkylsulphonylamino, aminothiocabonylthio, N-(C<sub>1-4</sub>alkyl)aminothiocabonylthio, N,N-(C<sub>1-4</sub>alkyl)<sub>2</sub>aminothiocabonylthio, carbocyclyl, heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>2</sup> may be optionally substituted on carbon by one or more groups selected from R<sup>6</sup>; and wherein if said  
 20 heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>7</sup>;

R<sup>3</sup> and R<sup>6</sup> are independently selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl, trifluoromethyl, trifluoromethoxy, C<sub>1-4</sub>alkyl, C<sub>2-4</sub>alkenyl, C<sub>2-4</sub>alkynyl, C<sub>1-4</sub>alkoxy, C<sub>1-4</sub>alkanoyl, C<sub>1-4</sub>alkanoyloxy, N-(C<sub>1-4</sub>alkyl)amino,  
 25 N,N-(C<sub>1-4</sub>alkyl)<sub>2</sub>amino, C<sub>1-4</sub>alkanoylamino, N-(C<sub>1-4</sub>alkyl)carbamoyl, N,N-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl, C<sub>1-4</sub>alkylS(O)<sub>a</sub> wherein a is 0 to 2, C<sub>1-4</sub>alkoxycarbonyl, C<sub>1-4</sub>alkoxycarbonylamino, C<sub>1-4</sub>alkoxycarbonyl-N-(C<sub>1-4</sub>alkyl)amino, N-(C<sub>1-4</sub>alkyl)sulphamoyl, N,N-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl, C<sub>1-4</sub>alkylsulphonylamino, carbocyclyl, heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>3</sup> and R<sup>6</sup> may be  
 30 independently optionally substituted on carbon by one or more R<sup>8</sup>; and wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>13</sup>;

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$R^4$ ,  $R^5$ ,  $R^7$ ,  $R^9$  and  $R^{13}$  are independently selected from  $C_{1-4}$ alkyl,  $C_{1-4}$ alkanoyl,  $C_{1-4}$ alkylsulphonyl,  $C_{1-4}$ alkoxycarbonyl, carbamoyl,  $N$ -( $C_{1-4}$ alkyl)carbamoyl,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>carbamoyl, benzyl, benzyloxycarbonyl, benzoyl and phenylsulphonyl;

$R^8$  is selected from halo, nitro, cyano, hydroxy, trifluoromethoxy, trifluoromethyl, amino, carboxy, carbamoyl, mercapto, sulphamoyl, methyl, ethyl, methoxy, ethoxy, acetyl, acetoxymethyl, methylamino, ethylamino, dimethylamino, diethylamino,  $N$ -methyl- $N$ -ethylamino, acetylamino,  $N$ -methylcarbamoyl,  $N$ -ethylcarbamoyl,  $N,N$ -dimethylcarbamoyl,  $N,N$ -diethylcarbamoyl,  $N$ -methyl- $N$ -ethylcarbamoyl, methylthio, ethylthio, methylsulphinyl, ethylsulphinyl, mesyl, ethylsulphonyl, methoxycarbonyl, ethoxycarbonyl,  $N$ -methylsulphamoyl,  $N$ -ethylsulphamoyl,  $N,N$ -dimethylsulphamoyl,  $N,N$ -diethylsulphamoyl or  $N$ -methyl- $N$ -ethylsulphamoyl;

$Z$  is  $-S(O)_a-$ ,  $-O-$ ,  $-NR^{10}-$ ,  $-C(O)-$ ,  $-C(O)NR^{10}-$ ,  $-NR^{10}C(O)-$ ,  $-OC(O)NR^{10}-$  or  $-SO_2NR^{10}-$ ; wherein  $a$  is 0 to 2; wherein  $R^{10}$  is selected from hydrogen and  $C_{1-4}$ alkyl;

$R^{12}$  is hydroxy, methyl, ethyl or propyl;

$m$  is 0 or 1;

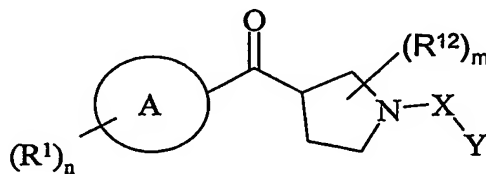
$q$  is 0 or 1;

or a pharmaceutically acceptable salt thereof;

in the manufacture of a medicament for use in the inhibition of 11 $\beta$ HSD1.

For the avoidance of doubt, where  $X$  is  $-C(O)NR^{11}-$ ,  $-C(S)NR^{11}-$  or  $-C(O)O-$  is it the  $C(O)$  or the  $C(S)$  that is attached to the nitrogen of the pyrrolidine ring in formula (I).

According to a further feature of the invention there is provided a compound of formula (IA'):



(IA')

wherein:

**Ring A** is selected from phenyl, pyridyl, thienyl, furyl or thiazolyl;

$R^1$  is a substituent on carbon and is selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl,  $C_{1-4}$ alkyl,  $C_{2-4}$ alkenyl,  $C_{2-4}$ alkynyl,  $C_{1-4}$ alkoxy,  $C_{1-4}$ alkanoyl,  $C_{1-4}$ alkanoyloxy,  $N$ -( $C_{1-4}$ alkyl)amino,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>amino,



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C<sub>1-4</sub>alkanoylamino, *N*-(C<sub>1-4</sub>alkyl)carbamoyl, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl, C<sub>1-4</sub>alkylS(O)<sub>a</sub> wherein a is 0 to 2, C<sub>1-4</sub>alkoxycarbonyl, *N*-(C<sub>1-4</sub>alkyl)sulphamoyl,

*N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl, C<sub>1-4</sub>alkylsulphonylamino, carbocyclyl, heterocyclyl,

carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>1</sup> may be optionally

5 substituted on carbon by one or more groups selected from R<sup>3</sup>; and wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>4</sup>;

n is 0-5; wherein the values of R<sup>1</sup> may be the same or different;

10 X is a -C(O)-, -S(O)<sub>2</sub>-, -C(O)NR<sup>11</sup>-, -C(S)NR<sup>11</sup>-, -C(O)O-, -C(=NR<sup>11</sup>)-, wherein R<sup>11</sup> is selected from hydrogen, C<sub>1-4</sub>alkyl, carbocyclyl and heterocyclyl;

Y is C<sub>1-6</sub>alkyl, C<sub>2-6</sub>alkenyl, C<sub>2-6</sub>alkynyl, carbocyclyl or heterocyclyl; wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>; wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>5</sup>;

15 R<sup>2</sup> is a substituent on carbon and is selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl, trifluoromethyl, trifluoromethoxy, C<sub>1-4</sub>alkyl, C<sub>2-4</sub>alkenyl, C<sub>2-4</sub>alkynyl, C<sub>1-4</sub>alkoxy, C<sub>1-4</sub>alkanoyl, C<sub>1-4</sub>alkanoyloxy, *N*-(C<sub>1-4</sub>alkyl)amino, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>amino, C<sub>1-4</sub>alkanoylamino, *N*-(C<sub>1-4</sub>alkyl)carbamoyl, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl, C<sub>1-4</sub>alkylS(O)<sub>a</sub> wherein a is 0 to 2, C<sub>1-4</sub>alkoxycarbonyl, C<sub>1-4</sub>alkoxycarbonylamino, C<sub>1-4</sub>alkoxycarbonyl-*N*-(C<sub>1-4</sub>alkyl)amino, *N*-(C<sub>1-4</sub>alkyl)sulphamoyl, 20 *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl, C<sub>1-4</sub>alkylsulphonylamino, aminothiocabonylthio, *N*-(C<sub>1-4</sub>alkyl)aminothiocabonylthio, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>aminothiocabonylthio, carbocyclyl, heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>2</sup> may be optionally substituted on carbon by one or more groups selected from R<sup>6</sup>; and wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group 25 selected from R<sup>7</sup>;

R<sup>3</sup> and R<sup>6</sup> are independently selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl, trifluoromethyl, trifluoromethoxy, C<sub>1-4</sub>alkyl, C<sub>2-4</sub>alkenyl, C<sub>2-4</sub>alkynyl, C<sub>1-4</sub>alkoxy, C<sub>1-4</sub>alkanoyl, C<sub>1-4</sub>alkanoyloxy, *N*-(C<sub>1-4</sub>alkyl)amino, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>amino, C<sub>1-4</sub>alkanoylamino, *N*-(C<sub>1-4</sub>alkyl)carbamoyl, 30 *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl, C<sub>1-4</sub>alkylS(O)<sub>a</sub> wherein a is 0 to 2, C<sub>1-4</sub>alkoxycarbonyl, C<sub>1-4</sub>alkoxycarbonylamino, C<sub>1-4</sub>alkoxycarbonyl-*N*-(C<sub>1-4</sub>alkyl)amino, *N*-(C<sub>1-4</sub>alkyl)sulphamoyl, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl, C<sub>1-4</sub>alkylsulphonylamino, carbocyclyl, heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>3</sup> and R<sup>6</sup> may be

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independently optionally substituted on carbon by one or more  $R^8$ ; and wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from  $R^{13}$ ;

$R^4$ ,  $R^5$ ,  $R^7$  and  $R^{13}$  are independently selected from  $C_{1-4}$ alkyl,  $C_{1-4}$ alkanoyl,

- 5  $C_{1-4}$ alkylsulphonyl,  $C_{1-4}$ alkoxycarbonyl, carbamoyl,  $N$ -( $C_{1-4}$ alkyl)carbamoyl,  $N,N$ -( $C_{1-4}$ alkyl) $_2$ carbamoyl, benzyl, benzyloxycarbonyl, benzoyl and phenylsulphonyl;

- $R^8$  is selected from halo, nitro, cyano, hydroxy, trifluoromethoxy, trifluoromethyl, amino, carboxy, carbamoyl, mercapto, sulphamoyl, methyl, ethyl, methoxy, ethoxy, acetyl, acetoxymethyl, methylamino, ethylamino, dimethylamino, diethylamino,  $N$ -methyl- $N$ -ethylamino, 10 acetylaminomethyl,  $N$ -methylcarbamoyl,  $N$ -ethylcarbamoyl,  $N,N$ -dimethylcarbamoyl,  $N,N$ -diethylcarbamoyl,  $N$ -methyl- $N$ -ethylcarbamoyl, methylthio, ethylthio, methylsulphinyl, ethylsulphinyl, mesyl, ethylsulphonyl, methoxycarbonyl, ethoxycarbonyl,  $N$ -methylsulphamoyl,  $N$ -ethylsulphamoyl,  $N,N$ -dimethylsulphamoyl,  $N,N$ -diethylsulphamoyl or  $N$ -methyl- $N$ -ethylsulphamoyl;

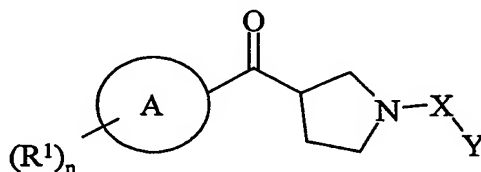
- 15  $R^{12}$  is hydroxy, methyl, ethyl, propyl or trifluoromethyl;

$m$  is 0 or 1;

$Z$  is  $-S(O)_a-$ ,  $-O-$ ,  $-NR^{10}-$ ,  $-C(O)-$ ,  $-C(O)NR^{10}-$ ,  $-NR^{10}C(O)-$ ,  $-OC(O)NR^{10}-$  or  $-SO_2NR^{10}-$ ; wherein  $a$  is 0 to 2; wherein  $R^{10}$  is selected from hydrogen and  $C_{1-4}$ alkyl; or a pharmaceutically acceptable salt thereof;

- 20 with the proviso that said compound is not: 1-(phenylsulphonyl)-3-(4-methoxybenzoyl)pyrrolidine; 1-(ethoxycarbonyl)-3-(benzoyl)pyrrolidine; 1-(acetyl)-3-(benzoyl)pyrrolidine; 1-(phenylsulphonyl)-3-(4-methylbenzoyl)pyrrolidine; 1-[ $N$ -(cyclopentyl)anilincarbonyl]-3-(benzoyl)pyrrolidine; 1-(benzoyl)-3-(4-mesylaminobenzoyl)pyrrolidine; 1-( $N$ -methylcarbamoyl)-3-(3-trifluoromethylbenzoyl)pyrrolidine; 1-(phenylsulphonyl)-3-(2-methylbenzoyl)pyrrolidine; or 1-(phenylsulphonyl)-3-(benzoyl)pyrrolidine.

In yet a further feature of the invention there is provided a compound of formula (IA):



(IA)

- 30 wherein:

Ring A is selected from phenyl, pyridyl, thienyl, furyl or thiazolyl;

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- $R^1$  is a substituent on carbon and is selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl,  $C_{1-4}$ alkyl,  $C_{2-4}$ alkenyl,  $C_{2-4}$ alkynyl,  $C_{1-4}$ alkoxy,  $C_{1-4}$ alkanoyl,  $C_{1-4}$ alkanoyloxy,  $N$ -( $C_{1-4}$ alkyl)amino,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>amino,  $C_{1-4}$ alkanoylamino,  $N$ -( $C_{1-4}$ alkyl)carbamoyl,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>carbamoyl,  $C_{1-4}$ alkylS(O)<sub>a</sub>
- 5 wherein a is 0 to 2,  $C_{1-4}$ alkoxycarbonyl,  $N$ -( $C_{1-4}$ alkyl)sulphamoyl,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>sulphamoyl,  $C_{1-4}$ alkylsulphonylamino, carbocyclyl, heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein  $R^1$  may be optionally substituted on carbon by one or more groups selected from  $R^3$ ; and wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group
- 10 selected from  $R^4$ ;
- n is 0-5; wherein the values of  $R^1$  may be the same or different;
- X is a -C(O)-, -S(O)<sub>2</sub>-, -C(O)NR<sup>11</sup>-, -C(S)NR<sup>11</sup>-, -C(O)O-, -C(=NR<sup>11</sup>)-; wherein  $R^{11}$  is selected from hydrogen,  $C_{1-4}$ alkyl, carbocyclyl and heterocyclyl;
- Y is  $C_{1-6}$ alkyl,  $C_{2-6}$ alkenyl,  $C_{2-6}$ alkynyl, carbocyclyl or heterocyclyl; wherein Y may
- 15 be optionally substituted on carbon by one or more  $R^2$ ; wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from  $R^5$ ;
- $R^2$  is a substituent on carbon and is selected from halo, nitro, cyano, hydroxy, amino, carboxy, carbamoyl, mercapto, sulphamoyl, trifluoromethyl, trifluoromethoxy,  $C_{1-4}$ alkyl,  $C_{2-4}$ alkenyl,  $C_{2-4}$ alkynyl,  $C_{1-4}$ alkoxy,  $C_{1-4}$ alkanoyl,  $C_{1-4}$ alkanoyloxy,  $N$ -( $C_{1-4}$ alkyl)amino,
- 20  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>amino,  $C_{1-4}$ alkanoylamino,  $N$ -( $C_{1-4}$ alkyl)carbamoyl,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>carbamoyl,  $C_{1-4}$ alkylS(O)<sub>a</sub> wherein a is 0 to 2,  $C_{1-4}$ alkoxycarbonyl,  $C_{1-4}$ alkoxycarbonylamino,  $C_{1-4}$ alkoxycarbonyl- $N$ -( $C_{1-4}$ alkyl)amino,  $N$ -( $C_{1-4}$ alkyl)sulphamoyl,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>sulphamoyl,  $C_{1-4}$ alkylsulphonylamino, aminothiocabonylthio,  $N$ -( $C_{1-4}$ alkyl)aminothiocabonylthio,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>aminothiocabonylthio, carbocyclyl,
- 25 heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein  $R^2$  may be optionally substituted on carbon by one or more groups selected from  $R^6$ ; and wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from  $R^7$ ;
- $R^3$  and  $R^6$  are independently selected from halo, nitro, cyano, hydroxy, amino,
- 30 carboxy, carbamoyl, mercapto, sulphamoyl, trifluoromethyl, trifluoromethoxy,  $C_{1-4}$ alkyl,  $C_{2-4}$ alkenyl,  $C_{2-4}$ alkynyl,  $C_{1-4}$ alkoxy,  $C_{1-4}$ alkanoyl,  $C_{1-4}$ alkanoyloxy,  $N$ -( $C_{1-4}$ alkyl)amino,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>amino,  $C_{1-4}$ alkanoylamino,  $N$ -( $C_{1-4}$ alkyl)carbamoyl,  $N,N$ -( $C_{1-4}$ alkyl)<sub>2</sub>carbamoyl,  $C_{1-4}$ alkylS(O)<sub>a</sub> wherein a is 0 to 2,  $C_{1-4}$ alkoxycarbonyl,

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C<sub>1-4</sub>alkoxycarbonylamino, C<sub>1-4</sub>alkoxycarbonyl-*N*-(C<sub>1-4</sub>alkyl)amino, *N*-(C<sub>1-4</sub>alkyl)sulphamoyl, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl, C<sub>1-4</sub>alkylsulphonylamino, carbocyclyl, heterocyclyl, carbocyclylC<sub>0-4</sub>alkylene-Z- and heterocyclylC<sub>0-4</sub>alkylene-Z-; wherein R<sup>3</sup> and R<sup>6</sup> may be independently optionally substituted on carbon by one or more R<sup>8</sup>; and wherein if said

5 heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>13</sup>;

R<sup>4</sup>, R<sup>5</sup>, R<sup>7</sup> and R<sup>13</sup> are independently selected from C<sub>1-4</sub>alkyl, C<sub>1-4</sub>alkanoyl, C<sub>1-4</sub>alkylsulphonyl, C<sub>1-4</sub>alkoxycarbonyl, carbamoyl, *N*-(C<sub>1-4</sub>alkyl)carbamoyl, *N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl, benzyl, benzyloxycarbonyl, benzoyl and phenylsulphonyl;

10 R<sup>8</sup> is selected from halo, nitro, cyano, hydroxy, trifluoromethoxy, trifluoromethyl, amino, carboxy, carbamoyl, mercapto, sulphamoyl, methyl, ethyl, methoxy, ethoxy, acetyl, acetoxymethyl, methylamino, ethylamino, dimethylamino, diethylamino, *N*-methyl-*N*-ethylamino, acetylamino, *N*-methylcarbamoyl, *N*-ethylcarbamoyl, *N,N*-dimethylcarbamoyl, *N,N*-diethylcarbamoyl, *N*-methyl-*N*-ethylcarbamoyl, methylthio, ethylthio, methylsulphinyl, ethylsulphinyl, mesyl, ethylsulphonyl, methoxycarbonyl, ethoxycarbonyl,

15 *N*-methylsulphamoyl, *N*-ethylsulphamoyl, *N,N*-dimethylsulphamoyl, *N,N*-diethylsulphamoyl or *N*-methyl-*N*-ethylsulphamoyl;

Z is -S(O)<sub>a</sub>-, -O-, -NR<sup>10</sup>-, -C(O)-, -C(O)NR<sup>10</sup>-, -NR<sup>10</sup>C(O)-, -OC(O)NR<sup>10</sup>- or -SO<sub>2</sub>NR<sup>10</sup>-; wherein a is 0 to 2; wherein R<sup>10</sup> is selected from hydrogen and C<sub>1-4</sub>alkyl;

20 or a pharmaceutically acceptable salt thereof;

with the proviso that said compound is not: 1-(phenylsulphonyl)-3-(4-methoxybenzoyl)pyrrolidine; 1-(ethoxycarbonyl)-3-(benzoyl)pyrrolidine; 1-(acetyl)-3-(benzoyl)pyrrolidine; 1-(phenylsulphonyl)-3-(4-methylbenzoyl)pyrrolidine; 1-[*N*-(cyclopentyl)anilino]carbonyl]-3-(benzoyl)pyrrolidine; 1-(benzoyl)-3-(4-mesylaminobenzoyl)pyrrolidine; 1-(*N*-methylcarbamoyl)-3-(3-trifluoromethylbenzoyl)pyrrolidine; 1-(phenylsulphonyl)-3-(2-methylbenzoyl)pyrrolidine; or 1-(phenylsulphonyl)-3-(benzoyl)pyrrolidine.

25

In this specification the term "alkyl" includes both straight and branched chain alkyl groups but references to individual alkyl groups such as "propyl" are specific for the straight

30 chain version only. For example, "C<sub>1-6</sub>alkyl" and "C<sub>1-4</sub>alkyl" includes propyl, isopropyl and *t*-butyl. However, references to individual alkyl groups such as 'propyl' are specific for the straight chained version only and references to individual branched chain alkyl groups such as 'isopropyl' are specific for the branched chain version only. A similar convention applies to

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other radicals therefore "carbocyclylC<sub>1-4</sub>alkyl" would include 1-carbocyclylpropyl, 2-carbocyclylethyl and 3-carbocyclylbutyl. The term "halo" refers to fluoro, chloro, bromo and iodo.

Where optional substituents are chosen from "one or more" groups it is to be understood that this definition includes all substituents being chosen from one of the specified groups or the substituents being chosen from two or more of the specified groups.

"Heteroaryl" is a totally unsaturated, mono or bicyclic ring containing 3-12 atoms of which at least one atom is chosen from nitrogen, sulphur or oxygen, which may, unless otherwise specified, be carbon or nitrogen linked. Suitably "heteroaryl" refers to a totally unsaturated, monocyclic ring containing 5 or 6 atoms or a bicyclic ring containing 8 - 10 atoms of which at least one atom is chosen from nitrogen, sulphur or oxygen, which may, unless otherwise specified, be carbon or nitrogen linked. Examples and suitable values of the term "heteroaryl" are thienyl, furyl, thiazolyl, pyrazolyl, isoxazolyl, imidazolyl, pyrrolyl, thiadiazolyl, isothiazolyl, triazolyl, pyranyl, indolyl, pyrimidyl, pyrazinyl, pyridazinyl, benzothienyl, pyridyl and quinolyl. Particularly "heteroaryl" refers to thienyl, furyl, thiazolyl, pyridyl, benzothienyl, imidazolyl or pyrazolyl.

"Aryl" is a totally unsaturated, mono or bicyclic carbon ring that contains 3-12 atoms. Suitably "aryl" is a monocyclic ring containing 5 or 6 atoms or a bicyclic ring containing 9 or 10 atoms. Suitable values for "aryl" include phenyl or naphthyl. Particularly "aryl" is phenyl.

A "heterocyclyl" is a saturated, partially saturated or unsaturated, mono, bicyclic or tricyclic ring containing 3-15 atoms of which at least one atom is chosen from nitrogen, sulphur or oxygen, which may, unless otherwise specified, be carbon or nitrogen linked, wherein a -CH<sub>2</sub>- group can optionally be replaced by a -C(O)- or a -C(S)-, or a ring sulphur atom may be optionally oxidised to form the S-oxides. Particularly a "heterocyclyl" is a saturated, partially saturated or unsaturated, mono or bicyclic ring containing 3-12 atoms of which at least one atom is chosen from nitrogen, sulphur or oxygen, which may, unless otherwise specified, be carbon or nitrogen linked, wherein a -CH<sub>2</sub>- group can optionally be replaced by a -C(O)- or a -C(S)-, or a ring sulphur atom may be optionally oxidised to form the S-oxides. More particularly a "heterocyclyl" is a saturated, partially saturated or unsaturated, mono or bicyclic ring containing 3-12 atoms of which at least one atom is chosen from nitrogen, sulphur or oxygen, which may, unless otherwise specified, be carbon or nitrogen linked, wherein a -CH<sub>2</sub>- group can optionally be replaced by a -C(O)- or a ring sulphur atom may be optionally oxidised to form the S-oxides. Preferably a "heterocyclyl" is

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a saturated, partially saturated or unsaturated, mono or bicyclic ring containing 5 or 6 atoms of which at least one atom is chosen from nitrogen, sulphur or oxygen, which may, unless otherwise specified, be carbon or nitrogen linked, wherein a -CH<sub>2</sub>- group can optionally be replaced by a -C(O)- or a ring sulphur atom may be optionally oxidised to form S-oxide(s).

- 5 Examples and suitable values of the term "heterocyclyl" are thienyl, piperidinyl, morpholinyl, furyl, thiazolyl, pyridyl, imidazolyl, 1,2,4-triazolyl, thiomorpholinyl, coumarinyl, pyrimidinyl, phthalidyl, pyrazolyl, pyrazinyl, pyridazinyl, benzothienyl, benzimidazolyl, tetrahydrofuryl, [1,2,4]triazolo[4,3-a]pyrimidinyl, piperidinyl, indolyl, 1,3-benzodioxolyl and pyrrolidinyl. Further examples and suitable values of the term "heterocyclyl" are
- 10 1,3-benzodioxolyl, thienyl, furyl, thiazolyl, pyrazinyl, pyrrolyl, indolyl, quinolinyl, isoquinolinyl, pyrazolyl, isoxazolyl, benzofuranyl, 1,2,3-thiadiazolyl, 1,2,5-thiadiazolyl, pyrimidinyl, 2,1-benzisoxazolyl, 4,5,6,7-tetrahydro-2*H*-indazolyl, imidazo[2,1-*b*][1,3]thiazolyl, tetrahydrofuranyl, tetrahydropyranyl, piperidinyl, morpholinyl, 2,3-dihydro-1-benzofuryl, 2,3-dihydro-1,4-benzodioxinyl and pyridyl. Further examples and
- 15 suitable values for the term "heterocyclyl" are benzofuranyl, 2,1-benzisoxazolyl, 1,3-benzodioxolyl, 1,3-benzothiazolyl, benzothienyl, 3,4-dihydro-2*H*-benzodioxepinyl, 2,3-dihydro-1,4-benzodioxinyl, chromanyl, 2,3-dihydrobenzofuranyl, furyl, imidazo[2,1-*b*][1,3]thiazolyl, indolyl, isoindolinyl, isoquinolinyl, isoxazolyl, morpholinyl, oxazolyl, piperidinyl, pyrazinyl, pyrazolyl, pyridyl, pyridazinyl, pyrimidinyl, pyrrolidinyl,
- 20 pyrrolyl, quinolinyl, quinoxalanyl, tetrahydrofuryl, 4,5,6,7-tetrahydro-1-benzofuryl, 4,5,6,7-tetrahydro-2*H*-indazolyl, 4,5,6,7-tetrahydro-1*H*-indolyl, tetrahydropyranyl, 1,2,3,4-tetrahydroquinolinyl, thiazolyl, 1,2,3-thiadiazolyl, 1,2,5-thiadiazolyl or thienyl.

- A "carbocyclyl" is a saturated, partially saturated or unsaturated, mono, bicyclic or tricyclic carbon ring that contains 3-15 atoms; wherein a -CH<sub>2</sub>- group can optionally be
- 25 replaced by a -C(O)-. Particularly a "carbocyclyl" is a saturated, partially saturated or unsaturated, mono or bicyclic carbon ring that contains 3-12 atoms; wherein a -CH<sub>2</sub>- group can optionally be replaced by a -C(O)-. Preferably "carbocyclyl" is a monocyclic ring containing 5 or 6 atoms or a bicyclic ring containing 9 or 10 atoms. Suitable values for "carbocyclyl" include cyclopropyl, cyclobutyl, 1-oxocyclopentyl, cyclopentyl, cyclopentenyl,
- 30 cyclohexyl, cyclohexenyl, phenyl, naphthyl, tetralinyl, indanyl or 1-oxoindanyl. Particularly "carbocyclyl" is cyclohexyl, phenyl, naphthyl or 2,6-dioxocyclohexyl. More particularly "carbocyclyl" is phenyl, naphthyl, cyclopropyl, cyclopentyl, cyclohexyl, 1,2,3,4-tetrahydronaphthyl or indenyl. More particularly "carbocyclyl" is naphthyl, phenyl,

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cyclopropyl, cyclohexyl, indenyl, 1,2,3,4-tetrahydronaphthyl, cyclopentyl or (3r)-adamantanyl.

An example of "C<sub>1-4</sub>alkanoyloxy" is acetoxy. Examples of "C<sub>1-4</sub>alkoxycarbonyl" include methoxycarbonyl, ethoxycarbonyl, *n*- and *t*-butoxycarbonyl. Examples of

- 5 "C<sub>1-4</sub>alkoxy" include methoxy, ethoxy and propoxy. Examples of "oxyC<sub>1-4</sub>alkoxy" include oxymethoxy, oxyethoxy and oxypropoxy. Examples of "C<sub>1-4</sub>alkanoylamino" include formamido, acetamido and propionylamino. Examples of and "C<sub>1-4</sub>alkylS(O)<sub>a</sub> wherein a is 0 to 2" include methylthio, ethylthio, methylsulphinyl, ethylsulphinyl, mesyl and ethylsulphonyl. Examples of and "C<sub>1-4</sub>alkylsulphonyl" include mesyl and ethylsulphonyl.
- 10 Examples of "C<sub>1-4</sub>alkanoyl" include propionyl and acetyl. Examples of "*N*-(C<sub>1-4</sub>alkyl)amino" include methylamino and ethylamino. Examples of "*N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>amino" include di-*N*-methylamino, di-(*N*-ethyl)amino and *N*-ethyl-*N*-methylamino. Examples of "C<sub>2-4</sub>alkenyl" are vinyl, allyl and 1-propenyl. Examples of "C<sub>2-4</sub>alkynyl" are ethynyl, 1-propynyl and 2-propynyl. Examples of "*N*-(C<sub>1-4</sub>alkyl)sulphamoyl" are
- 15 *N*-(methyl)sulphamoyl and *N*-(ethyl)sulphamoyl. Examples of "*N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>sulphamoyl" are *N,N*-(dimethyl)sulphamoyl and *N*-(methyl)-*N*-(ethyl)sulphamoyl. Examples of "*N*-(C<sub>1-4</sub>alkyl)carbamoyl" are methylaminocarbonyl and ethylaminocarbonyl. Examples of "*N,N*-(C<sub>1-4</sub>alkyl)<sub>2</sub>carbamoyl" are dimethylaminocarbonyl and methylethylaminocarbonyl. Examples of "C<sub>1-4</sub>alkylsulphonylamino" are mesylamino and ethylsulphonylamino. Examples
- 20 of "C<sub>0-4</sub>alkylene" are a direct bond, methylene and ethylene.

A suitable pharmaceutically acceptable salt of a compound of the invention is, for example, an acid-addition salt of a compound of the invention which is sufficiently basic, for example, an acid-addition salt with, for example, an inorganic or organic acid, for example hydrochloric, hydrobromic, sulphuric, phosphoric, trifluoroacetic, citric or maleic acid. In

- 25 addition a suitable pharmaceutically acceptable salt of a compound of the invention which is sufficiently acidic is an alkali metal salt, for example a sodium or potassium salt, an alkaline earth metal salt, for example a calcium or magnesium salt, an ammonium salt or a salt with an organic base which affords a physiologically-acceptable cation, for example a salt with methylamine, dimethylamine, trimethylamine, piperidine, morpholine or
- 30 tris-(2-hydroxyethyl)amine.

Some compounds of the formula (I) may have chiral centres and/or geometric isomeric centres (*E*- and *Z*- isomers), and it is to be understood that the invention

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encompasses all such optical, diastereoisomers and geometric isomers that possess 11 $\beta$ HSD1 inhibitory activity.

The invention relates to any and all tautomeric forms of the compounds of the formula (I) that possess 11 $\beta$ HSD1 inhibitory activity.

5 It is also to be understood that certain compounds of the formula (I) can exist in solvated as well as unsolvated forms such as, for example, hydrated forms. It is to be understood that the invention encompasses all such solvated forms which possess 11 $\beta$ HSD1 inhibitory activity.

Particular values of variable groups are as follows. Such values may be used where  
10 appropriate with any of the definitions, claims or embodiments defined hereinbefore or hereinafter.

#### Definitions for A

- a) Ring A is aryl.
- b) Ring A is heteroaryl; wherein if said heteroaryl contains an -NH- moiety that  
15 nitrogen may be optionally substituted by a group selected from R<sup>9</sup>.
- c) Ring A is aryl or heteroaryl; wherein if said heteroaryl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>9</sup>.
- d) Ring A is carbocyclyl.
- e) Ring A is heterocyclyl; wherein if said heterocyclyl contains an -NH- moiety  
20 that nitrogen may be optionally substituted by a group selected from R<sup>9</sup>.
- f) Ring A is phenyl.
- g) Ring A is phenyl wherein the positions ortho to the (CH<sub>2</sub>)<sub>q</sub> group are unsubstituted or substituted by fluoro, preferably unsubstituted.

#### Definitions for R<sup>1</sup>

- 25 a) R<sup>1</sup> is selected from halo or C<sub>1-4</sub>alkyl.
- b) R<sup>1</sup> is halo.
- c) R<sup>1</sup> is selected from fluoro, chloro, methoxy or methyl.
- d) R<sup>1</sup> is selected from fluoro.

#### 30 Definitions for n

- a) n is 0-3; wherein the values of R<sup>1</sup> may be the same or different.
- b) n is 0-2; wherein the values of R<sup>1</sup> may be the same or different.
- c) n is 0 or 1.



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- d) n is 2; wherein the values of  $R^1$  may be the same or different.
- e) n is 1.
- f) n is 0.

5 Particular combinations of A,  $R^1$  and n:

Ring A is phenyl, n is 1 and the substituent is para to the  $-(CH_2)_q-$  group of formula

(I).

Ring A,  $R^1$  and n together form 4-fluorophenyl, 4-chlorophenyl and 4-methoxyphenyl.

Ring A,  $R^1$  and n together form 4-fluorophenyl.

10

Definitions for X

- a) X is  $-C(O)-$  or  $-S(O)_2-$ .
- b) X is  $-C(O)-$ .
- c) X is  $-S(O)_2-$ .
- 15 d) X is  $-CH_2-$ .
- e) X is  $-C(O)NR^{11}-$ ; wherein  $R^{11}$  is selected from hydrogen.
- f) X is  $-C(O)NR^{11}-$ ; wherein  $R^{11}$  is selected from  $C_{1-4}$ alkyl.
- g) X is  $-C(O)NR^{11}-$ ; wherein  $R^{11}$  is selected from methyl.
- h) X is  $-C(S)NR^{11}-$ ; wherein  $R^{11}$  is selected from hydrogen.
- 20 i) X is  $-C(S)NR^{11}-$ ; wherein  $R^{11}$  is selected from  $C_{1-4}$ alkyl.
- j) X is  $-C(O)O-$ .
- k) X is a direct bond.
- l) X is  $-C(=NR^{11})-$ ; wherein  $R^{11}$  is selected from hydrogen.
- m) X is  $-C(=NR^{11})-$ ; wherein  $R^{11}$  is selected from  $C_{1-4}$ alkyl.

25

Definitions for Y

- a) Y is  $C_{1-6}$ alkyl; wherein Y may be optionally substituted on carbon by one or more  $R^2$ .
- b) Y is carbocyclyl or heterocyclyl; wherein Y may be optionally substituted on
- 30 carbon by one or more  $R^2$ ; wherein if said heterocyclyl contains an  $-NH-$  moiety that nitrogen may be optionally substituted by a group selected from  $R^5$ .

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c) Y is carbocyclyl; wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>.

d) X is -C(O)-, -C(O)O- or -S(O)<sub>2</sub>-.

e) Y is heterocyclyl; wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>; wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>5</sup>.

f) Y is C<sub>1-6</sub>alkyl, carbocyclyl or heterocyclyl; wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>; wherein if said heterocyclyl contains an -NH- moiety that nitrogen may be optionally substituted by a group selected from R<sup>5</sup>.

g) Y is phenyl, thienyl, isopropyl, *t*-butyl, furyl, cyclopropyl, cyclohexyl, quinolinyl or benzothienyl; wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>.

h) Y is phenyl, thien-2-yl, isopropyl, *t*-butyl, furyl, cyclopropyl, cyclohexyl, quinolin-2-yl or benzothien-2-yl; wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>.

#### Definitions for R<sup>2</sup>

a) R<sup>2</sup> is a substituent on carbon and is selected from halo, cyano, C<sub>1-4</sub>alkyl or C<sub>1-4</sub>alkoxy; wherein R<sup>2</sup> may be optionally substituted on carbon by one or more groups selected from R<sup>6</sup>; wherein R<sup>6</sup> is halo.

b) R<sup>2</sup> is a substituent on carbon and is selected from fluoro, chloro, cyano, trifluoromethyl, ethoxy, isopropoxy, difluoromethoxy or trifluoromethoxy.

c) When Y is phenyl, R<sup>2</sup> is para to X.

#### Particular combinations of X and Y

X and Y together form *t*-butoxycarbonyl, cyclopropylcarbonyl, cyclohexylcarbonyl, benzoyl, 4-fluorobenzoyl, 2,5-difluorobenzoyl, 2-chlorobenzoyl, 4-chlorobenzoyl, 2-cyanobenzoyl, 4-ethoxybenzoyl, 4-isopropoxybenzoyl, 4-difluoromethoxybenzoyl, 2-trifluoromethoxybenzoyl, 3-trifluoromethoxybenzoyl, thien-2-ylcarbonyl, 5-trifluoromethylfur-2-ylcarbonyl, quinoline-2-ylcarbonyl, benzothien-2-ylcarbonyl, isopropylsulphonyl, 4-fluorophenylsulphonyl or thien-2-ylsulphonyl.

#### Definitions of R<sup>12</sup>

a) R<sup>12</sup> is hydroxy, methyl, ethyl, propyl or trifluoromethyl;

b) R<sup>12</sup> is hydroxy, methyl, ethyl or propyl;

c) R<sup>12</sup> is hydroxy, methyl, ethyl or trifluoromethyl;

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d)  $R^{12}$  is methyl or ethyl.e)  $R^{12}$  is methyl.Definitions of m

a) m is 0.

5 b) m is 1.

Definitions of q

a) q is 0.

b) q is 1.

10 Substituents on  $R^1$ ,  $R^2$ ,  $R^3$  and  $R^4$ In one aspect  $R^1$  is optionally substituted by 1, 2 or 3 groups selected from  $R^3$ .In one aspect  $R^1$  is optionally substituted by 1 or 2 groups selected from  $R^3$ .In one aspect  $R^1$  is optionally substituted by 1 group selected from  $R^3$ .In one aspect  $R^2$  is optionally substituted by 1, 2 or 3 groups selected from  $R^6$ .15 In one aspect  $R^2$  is optionally substituted by 1 or 2 groups selected from  $R^6$ .In one aspect  $R^2$  is optionally substituted by 1 group selected from  $R^6$ .In one aspect  $R^3$  is optionally substituted by 1, 2 or 3 groups selected from  $R^8$ .In one aspect  $R^3$  is optionally substituted by 1 or 2 groups selected from  $R^8$ .In one aspect  $R^3$  is optionally substituted by 1 group selected from  $R^8$ .20 In one aspect  $R^6$  is optionally substituted by 1, 2 or 3 groups selected from  $R^8$ .In one aspect  $R^6$  is optionally substituted by 1 or 2 groups selected from  $R^8$ .In one aspect  $R^6$  is optionally substituted by 1 group selected from  $R^8$ .

Particular classes of compounds that are useful in the manufacture of a medicament

25 for use in the inhibition of 11 $\beta$ HSD1 are disclosed in Table A using combinations of the definitions described hereinabove, wherein any other variables required in the definition are as given in the first definition of the compound of formula (I) at the beginning of the description. For example, 'a' in the column headed  $R^2$  in the table refers to definition (a) given for  $R^2$  hereinabove and 'I' refers to the first definition given for the variables in the

30 compound of formula (I) at the beginning of the description. Certain classes of compounds may be novel as compounds in their own right.

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Table A

Class	Ring A	R <sup>1</sup>	n	q	X	Y	R <sup>12</sup>	m
1	I	I	a	I	I	I	I	I
2	I	I	a	I	I	I	a	a
3	c	I	b	I	I	I	a	b
4	c	a	b	I	I	a	b	a
5	d	a	c	I	a	a	c	b
6	e	I	b	I	a	e	c	b
7	f	a	c	b	b	e	c	b
8	f	b	e	a	b	f	d	b
9	g	c	f	a	c	f	d	b
10	g	d	e	a	b	g	e	b

According to a further feature of the invention there is provided the use of a compound of formula (I) wherein:

5 Ring A is phenyl;

R<sup>1</sup> is selected from halo;

n is 0 or 1;

X is -C(O)-, -C(O)O- or -S(O)<sub>2</sub>-;

Y is phenyl, thienyl, isopropyl, *t*-butyl, furyl, cyclopropyl or cyclohexyl, quinolinyl or  
10 benzothienyl; wherein Y may be optionally substituted on carbon by one or more R<sup>2</sup>;

R<sup>2</sup> is a substituent on carbon and is selected from halo, cyano, C<sub>1-4</sub>alkyl or C<sub>1-4</sub>alkoxy;  
wherein R<sup>2</sup> may be optionally substituted on carbon by one or more groups selected from R<sup>6</sup>;  
wherein R<sup>6</sup> is halo;

R<sup>12</sup> is methyl, ethyl or trifluoromethyl;

15 R<sup>12</sup> is methyl or ethyl;

m is 0 or 1; or

q is 0;

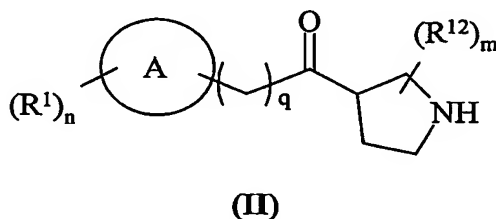
in the manufacture of a medicament for use in the inhibition of 11 $\beta$ HSD1.

In another aspect of the invention, suitable compounds of the invention are any one of  
20 the Examples or a pharmaceutically acceptable salt thereof.

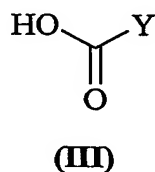
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Another aspect of the present invention provides a process for preparing a compound of formula (I) or a pharmaceutically acceptable salt thereof which process (wherein variable groups are, unless otherwise specified, as defined in formula (I)) comprises of:

*Process 1)* for compounds of formula (I) wherein X is -C(O)-; reacting an amine of formula (II):

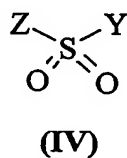


with an acid of formula (III):



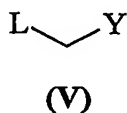
or an activated derivative thereof;

*Process 2)* for compounds of formula (I) wherein X is -S(O)<sub>2</sub>-; reacting an amine of formula (II) with a sulphonyl halide of formula (IV):



wherein Z is fluoro or chloro;

*Process 3)* for compounds of formula (I) wherein X is -CH<sub>2</sub>-; reacting an amine of formula (II) with a compound of formula (V):



wherein L is a displaceable group;

*Process 4)* for compounds of formula (I) wherein X is -CH<sub>2</sub>-; reducing a compound of formula (I) wherein X is -C(O)-;

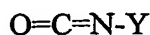
*Process 5)* for compounds of formula (I) wherein X is a direct bond; reacting an amine of formula (II) with a compound of formula (VI):



wherein L is a displaceable group;

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*Process 6)* for compounds of formula (I) wherein X is -C(O)NR<sup>11</sup>- and R<sup>11</sup> is hydrogen; reacting an amine of formula (II) with an isocyanate of formula (VII):



(VII)

5 *Process 7)* for compounds of formula (I) wherein X is -C(S)NR<sup>11</sup>- and R<sup>11</sup> is hydrogen; reacting an amine of formula (II) with an isothiocyanate of formula (VIII):



(VIII)

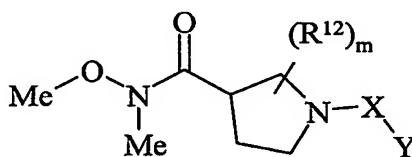
*Process 8)* for compounds of formula (I) wherein X is -C(O)O-; reacting an amine of formula  
10 (II) with a compound of formula (IX):



(IX)

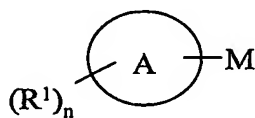
wherein L is a displaceable group;

*Process 9)* for compounds of formula (I) wherein q is 0; reacting a Weinreb amide of the  
15 formula (X):



(X)

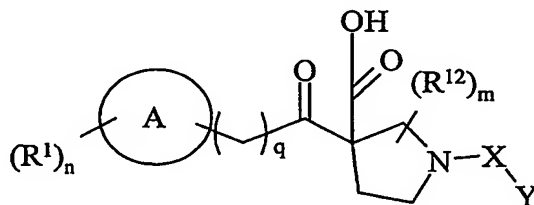
with a compound of formula (XI):



(XI)

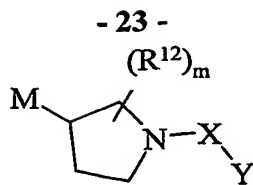
wherein M is an organometallic reagent;

*Process 10)* decarboxylating a compound of formula (XII):



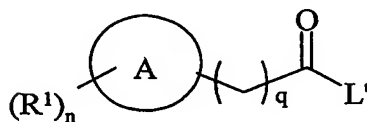
(XII)

25 *Process 11)* reacting a compound of formula (XIII):



(XIII)

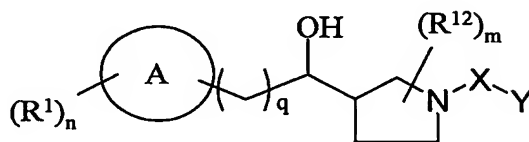
wherein M is an organometallic reagent, with a compound of formula (XIV):



(XIV)

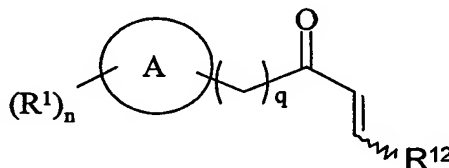
5

Process 12) oxidising a compound of formula (XV):



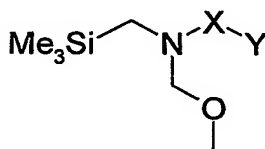
(XV)

Process 13) when X is -CO- forming a pyrrolidine ring by primary synthesis by reacting a  
10 compound of formula (XVI):



(XVI)

with a compound of formula (XVII):



(XVII)

15

and thereafter if necessary or desirable:

- i) converting a compound of the formula (I) into another compound of the formula (I);
- ii) removing any protecting groups;
- iii) resolving enantiomers;
- 20 iv) forming a pharmaceutically acceptable salt thereof.

An example of an activated derivative of a compound of formula (III) is the corresponding acid chloride.

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L is a displaceable group, suitable values for L include halo, particularly chloro or bromo, or mesyloxy.

M is an organometallic reagent, preferably a Grignard reagent, more preferably magnesium bromide.

5 L' is a leaving group, for example, halo or an activated ester.

Suitable oxidizing agents for oxidizing the hydroxyl group in a compound of the formula (XV) include Dess-Martin periodinane (1,1,1-tris (acetyloxy)-1,1-dihydro-1,2-benziodoxol-3-(1H)-one); pyridinium chlorochromate in DCM; sodium dichromate, sulfuric acid, acetone (Jones Oxidation); sodium or potassium permanganate; DMSO, oxalyl chloride, triethylamine  
10 (Swern oxidation); and hydrogen peroxide.

The reactions described above may be performed under standard conditions known to the person skilled in the art. The intermediates described above are commercially available, are known in the art or may be prepared by known procedures.

It will be appreciated that certain of the various ring substituents in the compounds of  
15 the present invention may be introduced by standard aromatic substitution reactions or generated by conventional functional group modifications either prior to or immediately following the processes mentioned above, and as such are included in the process aspect of the invention. Such reactions and modifications include, for example, introduction of a substituent by means of an aromatic substitution reaction, reduction of substituents, alkylation  
20 of substituents and oxidation of substituents. The reagents and reaction conditions for such procedures are well known in the chemical art. Particular examples of aromatic substitution reactions include the introduction of a nitro group using concentrated nitric acid, the introduction of an acyl group using, for example, an acyl halide and Lewis acid (such as aluminium trichloride) under Friedel Crafts conditions; the introduction of an alkyl group  
25 using an alkyl halide and Lewis acid (such as aluminium trichloride) under Friedel Crafts conditions; and the introduction of a halogeno group. Particular examples of modifications include the reduction of a nitro group to an amino group by for example, catalytic hydrogenation with a nickel catalyst or treatment with iron in the presence of hydrochloric acid with heating; oxidation of alkylthio to alkylsulphinyl or alkylsulphonyl.

30 It will also be appreciated that in some of the reactions mentioned herein it may be necessary/desirable to protect any sensitive groups in the compounds. The instances where protection is necessary or desirable and suitable methods for protection are known to those skilled in the art. Conventional protecting groups may be used in accordance with standard



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practice (for illustration see T.W. Green, Protective Groups in Organic Synthesis, John Wiley and Sons, 1991). Thus, if reactants include groups such as amino, carboxy or hydroxy it may be desirable to protect the group in some of the reactions mentioned herein.

A suitable protecting group for an amino or alkylamino group is, for example, an acyl group, for example an alkanoyl group such as acetyl, an alkoxycarbonyl group, for example a methoxycarbonyl, ethoxycarbonyl or *t*-butoxycarbonyl group, an arylmethoxycarbonyl group, for example benzyloxycarbonyl, or an aroyl group, for example benzoyl. The deprotection conditions for the above protecting groups necessarily vary with the choice of protecting group. Thus, for example, an acyl group such as an alkanoyl or alkoxycarbonyl group or an aroyl group may be removed for example, by hydrolysis with a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an acyl group such as a *t*-butoxycarbonyl group may be removed, for example, by treatment with a suitable acid as hydrochloric, sulphuric or phosphoric acid or trifluoroacetic acid and an arylmethoxycarbonyl group such as a benzyloxycarbonyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon, or by treatment with a Lewis acid for example boron tris(trifluoroacetate). A suitable alternative protecting group for a primary amino group is, for example, a phthaloyl group which may be removed by treatment with an alkylamine, for example dimethylaminopropylamine, or with hydrazine.

A suitable protecting group for a hydroxy group is, for example, an acyl group, for example an alkanoyl group such as acetyl, an aroyl group, for example benzoyl, or an arylmethyl group, for example benzyl. The deprotection conditions for the above protecting groups will necessarily vary with the choice of protecting group. Thus, for example, an acyl group such as an alkanoyl or an aroyl group may be removed, for example, by hydrolysis with a suitable base such as an alkali metal hydroxide, for example lithium or sodium hydroxide. Alternatively an arylmethyl group such as a benzyl group may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.

A suitable protecting group for a carboxy group is, for example, an esterifying group, for example a methyl or an ethyl group which may be removed, for example, by hydrolysis with a base such as sodium hydroxide, or for example a *t*-butyl group which may be removed, for example, by treatment with an acid, for example an organic acid such as trifluoroacetic acid, or for example a benzyl group which may be removed, for example, by hydrogenation over a catalyst such as palladium-on-carbon.

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The protecting groups may be removed at any convenient stage in the synthesis using conventional techniques well known in the chemical art.

As stated hereinbefore the compounds defined in the present invention possess 11 $\beta$ HSD1 inhibitory activity. These properties may be assessed using the following assay.

#### 5 Assay

HeLa cells (human cervical carcinoma derived cells) were stably transfected with a construct containing four copies of the glucocorticoid response element (GRE) linked to a beta-galactosidase reporter gene (3 kb lac Z gene derived from pSV-B-galactosidase). These cells were then further stably transfected with a construct containing full-length human 11 $\beta$ HSD1 enzyme (in pCMVHyg) to create GRE4- $\beta$ Gal/11 $\beta$ HSD1 cells. The principal of the assay is as follows. Cortisone is freely taken up by the cells and is converted to cortisol by 11 $\beta$ HSD1 oxo-reductase activity and cortisol (but not cortisone) binds to and activates the glucocorticoid receptor. Activated glucocorticoid receptor then binds to the GRE and initiates transcription and translation of  $\beta$ -galactosidase. Enzyme activity can then be assayed with high sensitivity by colourimetric assay. Inhibitors of 11 $\beta$ HSD1 will reduce the conversion of cortisone to cortisol and hence decrease the production of  $\beta$ -galactosidase.

Cells were routinely cultured in DMEM (Invitrogen, Paisley, Renfrewshire, UK) containing 10% foetal calf serum (LabTech), 1% glutamine (Invitrogen), 1% penicillin & streptomycin (Invitrogen), 0.5 mg/ml G418 (Invitrogen) & 0.5mg/ml hygromycin (Boehringer). Assay media was phenol red free-DMEM containing 1% glutamine, 1% penicillin & streptomycin.

Compounds (1mM) to be tested were dissolved in dimethyl sulphoxide (DMSO) and serially diluted into assay media containing 10% DMSO. Diluted compounds were then plated into transparent flat-bottomed 384 well plates (Matrix, Hudson NH, USA).

The assay was carried out in 384 well microtitre plate (Matrix) in a total volume of 50 $\mu$ l assay media consisting of cortisone (Sigma, Poole, Dorset, UK, 1 $\mu$ M), HeLa GRE4- $\beta$ Gal/11 $\beta$ HSD1 cells (10,000 cells) plus test compounds (3000 to 0.01 nM). The plates were then incubated in 5% O<sub>2</sub>, 95% CO<sub>2</sub> at 37°C overnight.

The following day plates were assayed by measurement of  $\beta$ -galactosidase production.

A cocktail (25 $\mu$ l) consisting of 10X Z-buffer (600 mM Na<sub>2</sub>HPO<sub>4</sub>, 400 mM NaH<sub>2</sub>PO<sub>4</sub>.2H<sub>2</sub>O, 100 mM KCl, 10 mM MgSO<sub>4</sub>.7H<sub>2</sub>O, 500 mM  $\beta$ -mercaptoethanol, pH 7.0), SDS (0.2%), chlorophenol red- $\beta$ -D-galactopyranoside (5mM, Roche Diagnostics) was added per well and plates incubated at 37°C for 3-4hours.  $\beta$ -Galactosidase activity was indicated by

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a yellow to red colour change (absorbance at 570nm) measured using a Tecan Spectrafluor Ultra.

The calculation of median inhibitory concentration ( $IC_{50}$ ) values for the inhibitors was performed using Origin 6.0 (Microcal Software, Northampton MA USA). Dose response curves for each inhibitor were plotted as OD units at each inhibitor concentration with relation to a maximum signal (cortisone, no compound) and  $IC_{50}$  values calculated. Compounds of the present invention typically show an  $IC_{50} < 10\mu M$ . For example the following results were obtained:

Example	$IC_{50}$
5	75 nM
7	70 nM
18	447nM

According to a further aspect of the invention there is provided a pharmaceutical composition which comprises a compound of formula (IA') or a pharmaceutically acceptable salt thereof or of the Examples, or a pharmaceutically acceptable salt thereof, as defined hereinbefore in association with a pharmaceutically-acceptable diluent or carrier.

The composition may be in a form suitable for oral administration, for example as a tablet or capsule, for parenteral injection (including intravenous, subcutaneous, intramuscular, intravascular or infusion) as a sterile solution, suspension or emulsion, for topical administration as an ointment or cream or for rectal administration as a suppository.

In general the above compositions may be prepared in a conventional manner using conventional excipients.

The compound of formula (I), or a pharmaceutically acceptable salt thereof, will normally be administered to a warm-blooded animal at a unit dose within the range 0.1 – 50 mg/kg that normally provides a therapeutically-effective dose. A unit dose form such as a tablet or capsule will usually contain, for example 1-1000 mg of active ingredient. However the daily dose will necessarily be varied depending upon the host treated, the particular route of administration, and the severity of the illness being treated. Accordingly the optimum dosage may be determined by the practitioner who is treating any particular patient.

We have found that the compounds defined in the present invention, or a pharmaceutically acceptable salt thereof, are effective  $11\beta$ HSD1 inhibitors, and accordingly have value in the treatment of disease states associated with metabolic syndrome.

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It is to be understood that where the term "metabolic syndrome" is used herein, this relates to metabolic syndrome as defined in 1) and/or 2) or any other recognised definition of this syndrome. Synonyms for "metabolic syndrome" used in the art include Reaven's Syndrome, Insulin Resistance Syndrome and Syndrome X. It is to be understood that where  
5 the term "metabolic syndrome" is used herein it also refers to Reaven's Syndrome, Insulin Resistance Syndrome and Syndrome X.

Also provided is a compound of the formula (I) as hereinabove defined for use in inhibiting 11 $\beta$ HSD1.

Also provided is a compound of the formula (I) as hereinabove defined for use in  
10 treating disease states associated with metabolic syndrome.

Also provided is a compound of the formula (I) as hereinabove defined for use in treating diabetes.

According to a further aspect of the present invention there is provided a compound of formula (IA') or a pharmaceutically acceptable salt thereof or of the Examples, or a  
15 pharmaceutically acceptable salt thereof, as defined hereinbefore for use in a method of prophylactic or therapeutic treatment of a warm-blooded animal, such as man.

Thus according to this aspect of the invention there is provided a compound of formula (IA') or a pharmaceutically acceptable salt thereof or of the Examples, or a pharmaceutically acceptable salt thereof, as defined hereinbefore for use as a medicament.

20 According to another feature of the invention there is provided the use of a compound of the formula of formula (IA') or a pharmaceutically acceptable salt thereof or of the Examples, or a pharmaceutically acceptable salt thereof, as defined hereinbefore in the manufacture of a medicament for use in the production of an 11 $\beta$ HSD1 inhibitory effect in a warm-blooded animal, such as man.

25 Where production of or producing an 11 $\beta$ HSD1 inhibitory effect is referred to suitably this refers to the treatment of metabolic syndrome. Alternatively, where production of an 11 $\beta$ HSD1 inhibitory effect is referred to this refers to the treatment of diabetes, obesity, hyperlipidaemia, hyperglycaemia, hyperinsulinemia or hypertension, particularly diabetes and obesity. Alternatively, where production of an 11 $\beta$ HSD1 inhibitory effect is referred to this  
30 refers to the treatment of glaucoma, osteoporosis, tuberculosis, dementia, cognitive disorders or depression.

According to a further feature of this aspect of the invention there is provided a method for producing an 11 $\beta$ HSD1 inhibitory effect in a warm-blooded animal, such as man,

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in need of such treatment which comprises administering to said animal an effective amount of a compound of formula (I), or a pharmaceutically acceptable salt thereof.

According to a further feature of this aspect of the invention there is provided a method for producing an 11 $\beta$ HSD1 inhibitory effect in a warm-blooded animal, such as man,

5 in need of such treatment which comprises administering to said animal an effective amount of a compound of formula (IA') or a pharmaceutically acceptable salt thereof or of the Examples, or a pharmaceutically acceptable salt thereof.

In addition to their use in therapeutic medicine, the compounds of formula (I), or a pharmaceutically acceptable salt thereof, are also useful as pharmacological tools in the  
10 development and standardisation of *in vitro* and *in vivo* test systems for the evaluation of the effects of inhibitors of 11 $\beta$ HSD1 in laboratory animals such as cats, dogs, rabbits, monkeys, rats and mice, as part of the search for new therapeutic agents.

The inhibition of 11 $\beta$ HSD1 described herein may be applied as a sole therapy or may involve, in addition to the subject of the present invention, one or more other substances  
15 and/or treatments. Such conjoint treatment may be achieved by way of the simultaneous, sequential or separate administration of the individual components of the treatment. Simultaneous treatment may be in a single tablet or in separate tablets. For example agents than might be co-administered with 11 $\beta$ HSD1 inhibitors, particularly those of the present invention, may include the following main categories of treatment:

- 20 1) Insulin and insulin analogues;
- 2) Insulin secretagogues including sulphonylureas (for example glibenclamide, glipizide), prandial glucose regulators (for example repaglinide, nateglinide), glucagon-like peptide 1 agonist (GLP1 agonist) (for example exenatide, liraglutide) and dipeptidyl peptidase IV inhibitors (DPP-IV inhibitors);
- 25 3) Insulin sensitising agents including PPAR $\gamma$  agonists (for example pioglitazone and rosiglitazone);
- 4) Agents that suppress hepatic glucose output (for example metformin);
- 5) Agents designed to reduce the absorption of glucose from the intestine (for example acarbose);
- 30 6) Agents designed to treat the complications of prolonged hyperglycaemia; e.g. aldose reductase inhibitors
- 7) Other anti-diabetic agents including phosphotyrosine phosphatase inhibitors, glucose 6 - phosphatase inhibitors, glucagon receptor antagonists, glucokinase activators,

- 30 -

glycogen phosphorylase inhibitors, fructose 1,6 bisphosphatase inhibitors,  
glutamine:fructose -6-phosphate amidotransferase inhibitors

8) Anti-obesity agents (for example sibutramine and orlistat);

9) Anti- dyslipidaemia agents such as, HMG-CoA reductase inhibitors (statins, eg  
pravastatin); PPAR $\alpha$  agonists (fibrates, eg gemfibrozil); bile acid sequestrants

(cholestyramine); cholesterol absorption inhibitors (plant stanols, synthetic inhibitors);  
ileal bile acid absorption inhibitors (IBATi), cholesterol ester transfer protein  
inhibitors and nicotinic acid and analogues (niacin and slow release formulations);

10) Antihypertensive agents such as,  $\beta$  blockers (eg atenolol, inderal); ACE inhibitors (eg  
lisinopril); calcium antagonists (eg. nifedipine); angiotensin receptor antagonists (eg  
candesartan),  $\alpha$  antagonists and diuretic agents (eg. furosemide, benzthiazide);

11) Haemostasis modulators such as, antithrombotics, activators of fibrinolysis and  
antiplatelet agents; thrombin antagonists; factor Xa inhibitors; factor VIIa inhibitors);  
antiplatelet agents (eg. aspirin, clopidogrel); anticoagulants (heparin and Low  
molecular weight analogues, hirudin) and warfarin; and

12) Anti-inflammatory agents, such as non-steroidal anti-inflammatory drugs (eg. aspirin)  
and steroidal anti-inflammatory agents (eg. cortisone).

In the above other pharmaceutical composition, process, method, use and medicament  
manufacture features, the alternative and preferred embodiments of the compounds of the

invention described herein also apply.

### Examples

The invention will now be illustrated in the following Examples, in which standard  
techniques known to the skilled chemist and techniques analogous to those described in these  
Examples may be used where appropriate, and in which, unless otherwise stated:

(i) evaporations were carried out by rotary evaporation in vacuo and work up procedures were  
carried out after removal of residual solids such as drying agents by filtration;

(ii) all reactions were carried out under an inert atmosphere at ambient temperature, typically  
in the range 18-25°C, with solvents of HPLC grade under anhydrous conditions, unless  
otherwise stated;

(iii) column chromatography (by the flash procedure) was performed on Silica gel 40-63  $\mu$ m  
(Merck);

(iv) yields are given for illustration only and are not necessarily the maximum attainable;

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- (v) the structures of the end products of the formula (I) were generally confirmed by nuclear (generally proton) magnetic resonance (NMR) and mass spectral techniques; magnetic resonance chemical shift values were measured in deuterated  $\text{CDCl}_3$  (unless otherwise stated) on the delta scale (ppm downfield from tetramethylsilane); proton data is quoted unless otherwise stated; spectra were recorded on a Varian Mercury-300 MHz, Varian Unity plus-400 MHz, Varian Unity plus-600 MHz or on Varian Inova-500 MHz spectrometer unless otherwise stated data was recorded at 400MHz; and peak multiplicities are shown as follows: s, singlet; d, doublet; dd, double doublet; t, triplet; tt, triple triplet; q, quartet; tq, triple quartet; m, multiplet; br, broad; ABq, AB quartet; ABd, AB doublet, ABdd, AB doublet of doublets; dABq, doublet of AB quartets; LCMS were recorded on a Waters ZMD, LC column xTerra MS  $\text{C}_8$ (Waters), detection with a HP 1100 MS-detector diode array equipped; mass spectra (MS) (loop) were recorded on VG Platform II (Fisons Instruments) with a HP-1100 MS-detector diode array equipped; unless otherwise stated the mass ion quoted is ( $\text{MH}^+$ );
- (vi) intermediates were not generally fully characterised and purity was assessed by thin layer chromatography (TLC), HPLC, infra-red (IR), MS or NMR analysis;
- (vii) where solutions were dried magnesium sulphate was the drying agent;
- (viii) the following abbreviations may be used hereinbefore or hereinafter:-
- |                         |   |
|-------------------------|---|
| DCM                     | dichloromethane;  |
| MeCN                    | acetonitrile;   |
| THF                     | tetrahydrofuran;  |
| HATU                    | O-(7-azabenzotriazol-1-yl)-n,n',n'-tetramethyluronium hexafluoro-phosphate; |
| PS-DIEA                 | Polymer Supported-Diisopropylethylamine (From Argonaut Technologies);       |
| DMAP                    | 4-dimethylaminopyridine;  |
| EDAC                    | 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride;                |
| DIEA                    | Diisopropylethylamine;  |
| EtOAc                   | ethyl acetate;  |
| TFA                     | trifluoroacetic acid; and   |
| Dess-Martin periodinane | (1,1,1-tris (acetyloxy)-1,1-dihydro-1,2-benziodoxol-3-(1H)-one);            |
- ix) where an Isolute SCX-2 column is referred to, this means an "ion exchange" extraction cartridge for adsorption of basic compounds, i.e. a polypropylene tube containing a benzenesulphonic acid based strong cation exchange sorbent, used according to the

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manufacturers instructions obtained from International Sorbent Technologies Limited, Dyffryn Business Park, Hengeod, Mid Glamorgan, UK, CF82 7RJ;

x) where an Isolute-NH<sub>2</sub> column is referred to, this means an "ion exchange" extraction cartridge for adsorption of acidic compounds, i.e. a polypropylene tube containing a amino  
5 silane covalently bonded to a silica particle used according to the manufacturers instructions obtained from International Sorbent Technologies Limited, Dyffryn Business Park, Hengeod, Mid Glamorgan, UK, CF82 7RJ;

xi) where as Isco CombiFlash Optix-10 parallel flash chromatography system is referred to this means an automated chromatography workstation capable of carrying out up to 10  
10 purifications in parallel via flash chromatography using pre packed silica cartridges;  
xii) where a "Biotage 90g silica column" is referred to this means an automated chromatography workstation capable of carrying out up to 4 purifications in parallel via flash chromatography using pre packed silica cartridges, eg Si 12+M available from Biotage Inc. A Dyax Corp. Company; and

15 xiii) where a "Genevac HT4" is referred to, this means a centrifugal evaporator capable of the simultaneous evaporation of multiple samples supplied by Genevac Ltd, The Sovereign Centre, Farthing Road, Ipswich, Suffolk IP1 5AP, UK.

### Example 1

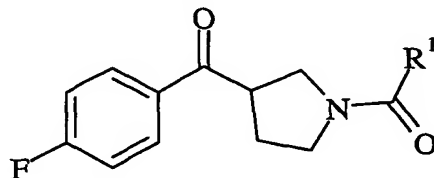
#### 20 (RS) 1-(4-Fluorobenzoyl)-3-(4-fluorobenzoyl)pyrrolidine

To a stirred solution of (RS) 3-(4-fluorobenzoyl)pyrrolidine hydrochloride (prepared according to J Med. Chem., 13(1), 1-6, (1970); 39mg, 0.17mmol) and triethylamine (31µl, 0.22mmol) in DCM (2ml) was added 4-fluorobenzoyl chloride (24mg, 0.15mmol). The reaction was left to stir at room temperature for 30 minutes then transferred to a separating  
25 funnel and diluted to ~15ml with DCM. The DCM was washed with 2M HCl (2 x 3ml), saturated NaHCO<sub>3</sub> (3ml) and brine (3ml) then dried, filtered and evaporated to yield the title compound as a solid (31mg, 59%). NMR (d<sub>6</sub>-DMSO): 2.10 (m, 1H), 2.20 (m, 1H), 3.60 (m, 2H), 3.75 (m, 1H), 3.80 (m, 1H), 4.20 (m, 1H), 7.20 (t, 2H), 7.35 (t, 2H), 7.60 (m, 2H), 8.10 (m, 2H); m/z 316.



**Examples 2-11**

The procedure described in Example 1 was repeated using the appropriate reagent to replace the "4-fluorobenzoyl chloride" to obtain the compounds described below.



5

Ex	R <sup>1</sup>	NMR	M/z
2	2-thienyl		304
3	Cyclopropyl		262
4	Phenyl	d <sup>6</sup> -DMSO: 1.95-2.05 (m, 1H), 2.1-2.4 (m, 1H), 3.4 -3.8 (m, 4H), 4.1-4.3 (m, 1H), 7.3-7.6 (m, 7H), 8.0-8.2 (m, 2H)	298
5	4-chlorophenyl	d <sup>6</sup> -DMSO: 1.9-2.1 (m, 1H), 2.1-2.4 (m, 1H), 3.4 -3.8 (m, 4H), 4.1-4.3 (m, 1H), 7.3-7.6 (m, 6H), 8.0-8.2 (m, 2H)	332
6	Cyclohexyl	d <sup>6</sup> -DMSO: 1.0 - 1.4 (m, 5H), 1.5 - 1.7 (m, 5H), 1.85-2.45 (m, 3H), 3.2 -3.8 (m, 4H), 4.1-4.3 (m, 1H), 7.3-7.4 (m, 2H), 8.00-8.2 (m, 2H)	304
7	2-chlorophenyl	2.14-2.47 (m, 2H), 3.30-3.70 (m, 2H), 3.74-4.16 (m, 3H), 7.08-7.22 (m, 2H), 7.27-7.44 (m, 4H), 7.90-8.06 (m, 2H)	332
8	3-trifluoromethoxy phenyl	2.12-2.49 (m, 2H), 3.46-4.15 (m, 5H), 7.09-7.23 (m, 2H), 7.23-7.32 (m, 1H), 7.35-7.55 (m, 3H), 7.89-8.07 (m, 2H)	383
9	4-difluoromethoxy phenyl	2.12-2.47 (br m, 2H), 3.49-4.15 (br m, 5H), 7.08-7.23 (m, 4H), 7.50-7.64 (br m, 2H), 7.91-8.07 (br m, 2H)	365
10	4-isopropoxy phenyl	1.18-1.43 (d, 6H), 2.04-2.44 (br m, 2H), 3.50-4.18 m, 5H), 4.50-4.66 (m, 1H), 6.80-6.93 (app d, 2H), 7.07-7.23 (m, 2H), 7.40-7.64 (m, 2H), 7.86-8.09 (m, 2H)	357
11	2-quinolinyl	2.19-2.46 (m, 2H), 3.80-4.43 (m, 5H), 7.10-7.23 (m, 2H), 7.55-7.65 (m, 1H), 7.68-7.80 (m, 1H), 7.81-7.90 (m, 1H), 7.92-8.14 (m, 4H), 8.22-8.30 (m, 1H)	350

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**Examples 12-17**

Examples 12-17 were prepared by the following general procedure.

To a solution of the appropriate acid component (0.5 mmol) in DMF (1ml) was added sequentially a solution of HATU (209 mgs) in DMF (1 ml), PS-DIEA (273mgs of 3.66 mmol/g) and a sonicated solution of (RS) 3-(4-fluorobenzoyl)pyrrolidine hydrochloride (prepared according to J Med. Chem., 13(1), 1-6, (1970); 139 mgs, 0.57mmol) and diisopropylethylamine (DIEA) (50.5 mgs, 0.07ml, 0.5 mmol) in DMF (1 - 2 ml), and the reaction mixture was aged for approximately 16 hours.

The products were purified by purification technique (a), (b) or (c) described below:

10 a) The reaction mixture was poured onto an Isolute SCX-2 column (1 g, 0.4mmol/g) aligned over an Isolute-NH<sub>2</sub> column (1 g, 0.6mmol/g) transferring with DCM (0.5ml). The columns were then eluted under atmospheric pressure with DCM. The bulk of the solvent was removed using a Genevac HT4 and then if necessary purified using the Isco CombiFlash Optix-10 parallel flash chromatography Optics-10 system (12g silica column, Gradient of  
15 isohexane/EtOAc, Flow rate 30 ml/min).

b) The bulk of the solvent was removed using a Genevac HT4 and then purified using the Isco CombiFlash Optix-10 parallel flash chromatography system Optics-10 system (12g silica column, Gradient of isohexane/EtOAc, Flow rate 30 ml/min).

c) Preparative LC-MS. Conditions:

20 Column: 19x50mm Xterra C18 5µm with guard

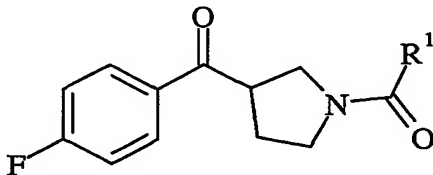
Time (mins)	A %	B %
0	95	5
1.02	95	5
6.50	0	100
6.60	0	100
8.5	0	100
9	95	5

A: water containing 1% ammonia

B: MeCN far UV grade

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It will be appreciated that various orders of addition, and various purification methods, or combinations of methods, can be employed to prepare the compounds exemplified below, and their congeners.

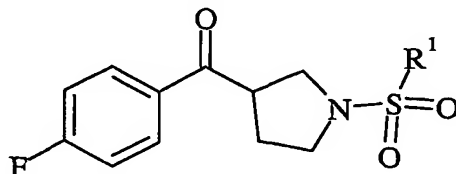


Ex	R <sup>1</sup>	NMR	M/z
12	2,5-difluoro phenyl	d <sup>6</sup> -DMSO: 1.89-2.08 (m, 1H), 2.14-2.39 (m, 1H), 3.22-3.45 (m, 1H), 3.46-3.60 (m, 2H), 3.65-3.85 (m, 1H), 4.11-4.36 (m, 1H), 7.25-7.43 (m, 5H), 8.00-8.16 (m, 2H)	334
13	2-cyano phenyl	d <sup>6</sup> -DMSO: 1.91-2.11 (m, 1H), 2.15-2.44 (m, 1H), 3.22-3.43 (m, 1H), 3.47-3.55 (m, 1H), 3.55-3.66 (m, 1H), 3.71-3.89 (m, 1H), 4.15-4.37 (m, 1H), 7.27-7.43 (m, 2H), 7.57-7.69 (m, 2H), 7.72-7.81 (m, 1H), 7.79-7.95 (m, 1H), 8.01-8.16 (m, 1H)	323
14	benzothien-2-yl	d <sup>6</sup> -DMSO: 1.97-2.23 (m, 1H), 2.23-2.44 (m, 1H), 3.54-3.71 (m, 1H), 3.71-4.01 (m, 2H), 4.01-4.22 (m, 1H), 4.22-4.43 (m, 1H), 7.29-7.49 (m, 4H), 7.89-8.03 (m, 3H), 8.07-8.19 (m, 2H)	354
15	2-trifluoro methoxy phenyl	d <sup>6</sup> -DMSO: 1.89-2.08 (m, 1H), 2.10-2.39 (m, 1H), 3.12-3.33 (m, 1H), 3.37-3.47(m, 1H), 3.52-3.63 (m, 1H), 3.68-3.84 (m, 1H), 4.13-4.34 (m, 1H), 7.26-7.61 (m, 6H), 7.98-8.16 (m, 2H)	
16	4-ethoxy phenyl		343
17	5-trifluoro methylfur-2-yl	d <sup>6</sup> -DMSO: 1.89-2.19 (m, 1H), 2.19-2.40 (m, 1H), 3.49-3.66 (m, 1H), 3.66-3.90 (m, 2H), 3.90-4.10 (m, 1H), 4.16-4.40 (m, 1H), 7.19-7.28 (m, 1H), 7.30-7.43 (m, 3H), 8.06-8.16 (m, 2H).	356

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**Examples 18 - 20**

The procedure described in Example 1 was repeated using the appropriate sulphonyl chloride to replace the "4-fluorobenzoyl chloride" to obtain the compounds described below. Where necessary, the compounds were purified using Preparative LC-MS (see above).



5

Ex	R <sup>2</sup>	M/z
18	4-fluorophenyl	352
19	thien-2-yl	340
20	isopropyl	300

**Example 21****(RS) 1-(4-Fluorobenzoyl)-3-methyl-3-(4-fluorobenzoyl)pyrrolidine**

To a stirred solution of 1-(4-fluorobenzoyl)-3-(4-fluorobenzoyl)pyrrolidine (Example 1; 95mg, 0.30mmol) in anhydrous THF (1.5ml) was added NaH (60% suspension in oil; 36mg, 0.90mmol). The reaction was warmed to 60°C and stirred at this temperature for two hours. The reaction was then cooled to room temp and treated with MeI (255mg, 1.8mmol). The reaction then warmed to 50°C and stirred at this temperature for 4 hours. The reaction was cooled to 0°C and quenched with sat NH<sub>4</sub>Cl solution (~2ml). The volatiles were removed under reduced pressure and the resulting crude product was partitioned between EtOAc (15ml) and water (15ml). The organic layer was separated and the water was reextracted with EtOAc (15ml). The combined organic layers were washed with brine (10ml) then dried, filtered and evaporated to yield an oil. This oil was purified by column chromatography eluting with isohexane containing EtOAc (20 – 60 % v/v) to yield the product as a white solid (28mg, 28%). NMR (d<sup>6</sup>-DMSO): 1.50 (s, 3H), 2.05 (m, 1H), 3.50 (m, 2H), 3.60 (m, 1H), 4.00 (d, 1H), 7.20 (t, 2H), 7.25 (t, 2H), 7.50 (m, 2H), 7.90 (m, 2H); m/z 330.

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**Example 22****(RS) 1-(4-Fluorobenzoyl)-3-ethyl-3-(4-fluorobenzoyl)pyrrolidine**

The procedure described in Example 21 was repeated using iodoethane to replace "iodomethane". NMR:  $d_6$ -DMSO: 0.75 (t, 3H), 2.00 (m, 2H), 2.15 (m, 1H), 3.45 (m, 1H),  
5 3.55 (m, 2H), 4.05 (d, 1H), 7.20 (t, 2H), 7.25 (t, 2H), 7.50 (m, 2H), 7.90 (m, 2H); m/z 344.

**Example 23****(RS) 3-(4-Fluorobenzoyl)-1-(tert-butyloxycarbonyl)pyrrolidine**

A solution of (RS) *N*-Boc-3-(*N*-methyl-*N*-methoxycarbamoyl)pyrrolidine (Method 1;  
10 4.3g, 20 mmol) in dry THF (60 ml) was cooled (ice-bath) under argon, and a solution of  
4-fluorophenyl magnesium bromide in ether (30ml of 2M, 3 eq) was added dropwise with  
stirring, keeping the internal temperature < 10°C. The reaction mixture was stirred for 3 hours,  
warming to ambient temperature, and then quenched with water. EtOAc (150 ml) and citric  
acid solution (30 ml of 1M) were added and the mixture shaken. The layers were separated  
15 and the EtOAc layer washed sequentially with water (twice) and brine, dried and evaporated  
to give the crude product as a yellow paste (6.4g). This was chromatographed (Biotage 90g  
silica column, eluting with hexane containing EtOAc, 10% rising to 15%) to give the title  
compound as a colourless solid (4g). A sample was recrystallised from cyclohexane. NMR  
( $d_6$ -DMSO): 1.40 (s, 9H), 1.95 (br s, 1H), 2.15 (m, 1H), 3.20 – 3.35 (m, 2H, signal obscured  
20 by HOD signal), 3.40 (m, 1H), 3.50 (m, 1H), 4.20 (br s, 1H), 7.40 (t, 2H), 8.10 (m, 2H); m/z  
294.

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**Examples 24 and 25****(R) and (S) 1-cyclohexylcarbonyl-3-(4-fluorobenzoyl)pyrrolidine**

Chiral semi-preparative HPLC was used to separate the enantiomers of (RS)

1-cyclohexylcarbonyl-3-(4-fluorobenzoyl)pyrrolidine (Example 6) to give the two isomers,

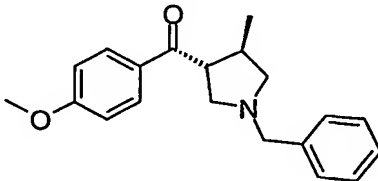
5 absolute stereochemistry unknown.

Conditions:

<b>Instrument</b>	<b>Gilson (200ml heads)</b>
Column	Merck 20µm 50mm Chiralpak AD No. AD00SC-HL001
Eluent	MeCN
Oven Temperature	Ambient
Flow	40ml/min
Wavelength	254nm
Sample Conc.	9.15mg/ml in MeCN
Sample Volume	20mls (183mgs)
Run Time	50mins

Ex	RT (mins)	NMR	M/z
24	25.56	d <sup>6</sup> -DMSO: 1.08-1.41 (m, 5H), 1.58-1.79 (m, 5H), 1.97-2.01 (m, 0.5H), 2.01-2.14 (m, 0.5H), 2.14-2.32 (m, 1H), 2.32-2.44 (m, 1H), 3.31-3.82 (m, 4H + H <sub>2</sub> O), 4.11-4.31 (app d of m, 1H), 7.34-7.44 (m, 2H), 8.07-8.16 (m, 2H)	304
25	33.16	d <sup>6</sup> -DMSO: 1.09-1.41 (m, 5H), 1.57-1.76 (m, 5H), 1.86-1.97 (m, 0.5H), 2.02-3.14 (m, 0.5H), 2.13-2.30 (m, 1H), 2.32-2.45 (m, 1H), 3.32-3.39 (m, 1H), 3.43-3.82 (m, 3H+H <sub>2</sub> O), 4.10-4.31 (app d of m, 1H), 7.34-7.43 (m, 2H), 8.08-8.17 (m, 2H)	304

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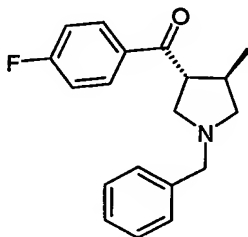
**Example 26*****trans*- 1-Benzyl-3-(4-methoxybenzoyl)-4-methyl-pyrrolidine**

5 N-benzyl-N-(methoxymethyl) trimethylsilylmethylamine (5.70 g) was added dropwise to a stirred solution of (2E)-1-(4-methoxyphenyl)but-2-en-1-one (3.52 g) in toluene (30 ml) at 0°C, under N<sub>2</sub>. After 20 minutes, a solution of TFA (0.154 ml) in toluene (6 ml) was added slowly; the mixture was stirred at 0°C for 1 hour, then allowed to warm to ambient temperature and stirred for 3 days. The solvent was removed *in vacuo*, and the residue taken  
10 up in DCM (100 ml); this was washed with water (100 ml), dried over MgSO<sub>4</sub> and concentrated *in vacuo*. The residue was purified by flash chromatography using a gradient of 0-30% EtOAc in hexane as eluent, to give the the title compound, (2.36 g); NMR: 1.13 (d, 3H), 2.39 (dd, 1H), 2.69-2.87 (m, 3H), 3.00 (m, 1H), 3.49 (q, 1H), 3.64 (m, 2H), 3.86 (s, 3H), 6.92 (d, 2H), 7.20-7.35 (m, 5H+CHCl<sub>3</sub>), 7.94 (d, 2H); m/z 310.

15

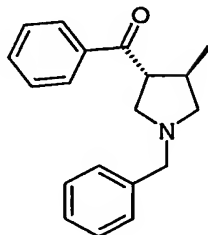
**Examples 27-28**

The procedure described in example 26 was repeated using the appropriate reagent to replace the "(2E)-1-(4-methoxyphenyl)but-2-en-1-one" to obtain the compounds described below.

**20 Example 27*****trans*- 1-Benzyl-3-(4-fluorobenzoyl)-4-methyl-pyrrolidine**

NMR: 1.12 (d, 3H), 2.38 (dd, 1H), 2.66-2.89 (m, 3H), 2.95-3.04 (m, 1H), 3.47 (q, 1H), 3.57-  
25 3.71 (m, 2H), 7.12 (t, 2H), 7.23-7.34 (m, 5H+CHCl<sub>3</sub>), 7.98 (dd, 2H); m/z 298.

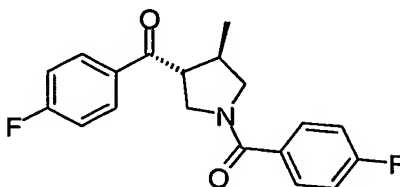
- 40 -

**Example 28*****trans*- 1-Benzyl-3-benzoyl-4-methyl-pyrrolidine**

5 NMR: 1.13 (d, 3H), 2.40 (dd, 1H), 2.70-2.89 (m, 3H), 3.00 (m, 1H), 3.49-3.72 (m, 3H), 7.20-7.35 (m, 5H+CHCl<sub>3</sub>), 7.45 (t, 2H), 7.55 (t, 1H), 7.95 (d, 2H); m/z 280.

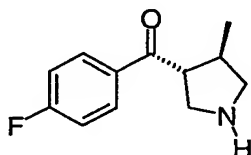
**Example 29*****trans*- 1-(4-Fluorobenzoyl)-3-(4-fluorobenzoyl)-4-methyl pyrrolidine**

10



4-fluorobenzoyl chloride (0.75 ml) was added to a stirred solution of *trans*-3-(4-fluorobenzoyl)-4-methyl pyrrolidine (0.110 g) and triethylamine (0.222 ml) in DCM (10 ml) at 0°C. After the addition the solution was allowed to warm to ambient temperature and  
15 stirred for a further 16 hours. The reaction mixture was diluted with DCM (40 ml), washed with water (30 ml), dried over MgSO<sub>4</sub> and concentrated *in vacuo*. The residue was purified by flash chromatography using a gradient of 0-50% EtOAc in hexane as eluent, to yield the title compound (0.072 g); NMR: mixture of rotamers in a ratio of 1:1, 1.10 (br, 1.5H), 1.17 (br, 1.5H), 2.74 (br, 1H), 3.22 (br, 0.5H), 3.41 (br, 0.5H), 3.62-3.86 (m, 3H), 3.94 (br, 0.5H), 4.14  
20 (br, 0.5H), 7.03-7.23 (m, 4H), 7.56 (br, 2H), 8.00 (br, 2H); m/z 330.

The requisite *trans*- 3-(4-fluorobenzoyl)-4-methyl pyrrolidine starting material was prepared as follows:-



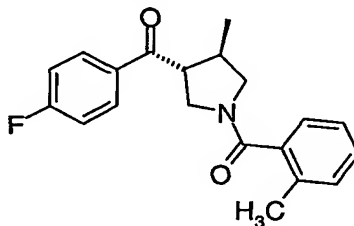


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1-chloroethyl chloroformate (0.222 ml) was added to a stirred solution of *trans*-1-benzyl-3-(4-fluorobenzoyl)-4-methyl-pyrrolidine (0.407 g) (prepared as described in Example 2) in dichloroethane (10 ml) at 0°C. The reaction mixture was heated at 85°C for 1.5 hours, at which time extra 1-chloroethyl chloroformate (0.222 ml) was added., and the reaction mixture stirred for a further 2 hours at 85°C. The solvent was removed *in vacuo* and the residue taken up in MeOH (10 ml); this solution was stirred at 68°C for 2 hours, and the solvent again removed *in vacuo*. The residue was purified by preparative HPLC using a 21mm Phenomenex isox C18 column, eluting with a gradient of 5-95% MeCN in water containing 0.2% TFA to give the title compound (0.115 g); NMR: 1.24 (d, 3H), 2.70 (m, 1H), 3.10 (br, 1H), 3.52-3.90 (m, 4H+H<sub>2</sub>O), 7.20 (t, 2H), 8.00 (dd, 2H); m/z 208.

**Example 30**

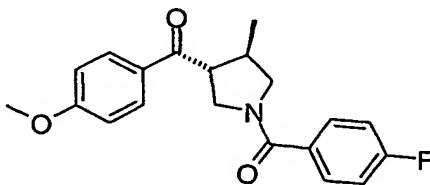
*trans*- 1-(2-Methylbenzoyl)-3-(4-fluorobenzoyl)-4-methyl pyrrolidine



The procedure described in Example 29 was repeated using *o*-toluoyl chloride to replace the 4-fluorobenzoyl chloride to obtain the title compound, NMR: mixture of rotamers A and B in a ratio of 4:6 respectively, 1.07 (d, 3H(B)), 1.18 (d, 3H(A)), 2.34 (s, 3H(B)), 2.36 (s, 3H(A)), 2.69 (m, 1H(A+B)), 2.91 (dd, 1H(B)), 3.37-3.52 (m, 3H(A) + 1H(B)), 3.64 (m, 1H(A+B)), 3.80 (m, 1H(B)), 3.98 (m, 1H(A)), 4.15 (m, 1H(B)), 7.12-7.30 (m, 6H(A+B)+CHCl<sub>3</sub>) 7.93 (m, 2H(A)), 8.01 (m, 2H(B)); m/z 326.

**Example 31**

*trans*- 1-(4-Fluorobenzoyl)-3-(4-methoxybenzoyl)-4-methyl pyrrolidine



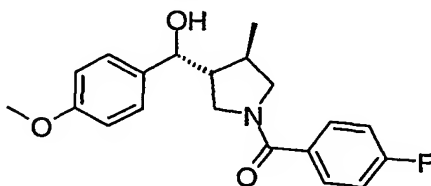
Dess-Martin periodinane (15% solution in DCM) (3.10g) was added to a stirred solution of *trans*- [1-(4-fluorobenzoyl)-4-methylpyrrolidin-3-yl](4-methoxyphenyl)methanol

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diastereoisomer 2 (0.367 g) in DCM (15 ml). The reaction mixture was stirred at ambient temperature for 3 hours and then diluted with DCM (30 ml), washed with water (20 ml), dried over  $\text{MgSO}_4$  and concentrated *in vacuo*. The residue was purified by flash chromatography using a gradient of 0-70% EtOAc in hexane as eluent, to yield the title compound (0.188 g);

5 NMR ( $\text{DMSO-d}_6$  at  $100^\circ\text{C}$ ): 1.05 (d, 3H), 2.53 (m, 1H), 3.20 (dd, 1H), 3.59 (m, 1H), 3.71 (m, 1H), 3.80-3.90 (m, 5H), 7.05 (d, 2H), 7.20 (t, 2H), 7.57 (m, 2H), 7.96 (d, 2H);  $m/z$  342.

The requisite *trans*- [1-(4-fluorobenzoyl)-4-methylpyrrolidin-3-yl](4-methoxyphenyl)methanol starting material was prepared as follows:-



10

A solution of *trans*- 1-benzyl-3-(4-methoxybenzoyl)-4-methyl-pyrrolidine (2.36 g) in ethanol (60 ml) was treated with palladium catalyst (20% Pd on carbon, 0.250 g) and the reaction mixture stirred for 6 hours under an atmosphere of hydrogen at 50psi. The reaction mixture was filtered through celite, and the solvent removed *in vacuo*. The residue was purified by

15 flash chromatography using a gradient of 0-100% EtOAc in *iso*-hexanes, then 0-20% MeOH in a mixture of DCM and  $\text{NH}_3\text{OH}$  (99:1), to yield *trans*-(4-methoxyphenyl)(4-methylpyrrolidin-3-yl)methanol as two separate distereoisomers.

**Diastereoisomer 1** (0.391 g); NMR ( $\text{DMSO-d}_6$  at  $100^\circ\text{C}$ ): 0.93 (d, 3H), 2.05-2.15 (m, 1H), 2.17-2.26 (m, 1H), 2.64 (m, 1H), 2.77 (m, 1H), 3.02 (m, 1H), 3.23 (m, 1H), 3.74 (s, 3H), 4.54

20 (d, 1H), 6.88 (d, 2H), 7.23 (d, 2H);  $m/z$  222.

**Diastereoisomer 2** (0.312 g); NMR ( $\text{DMSO-d}_6$ ): 0.89 (d, 3H), 1.79 (m, 1H), 1.99 (m, 1H), 2.24 (m, 1H), 2.24 (m, 1H), 2.40 (m, 1H), 2.55 (m, 1H), 2.92 (m, 1H), 3.71 (s, 3H), 4.33 (d, 1H), 6.83 (d, 2H), 7.20 (d, 2H);  $m/z$  222.

25 4-fluorobenzoyl chloride (0.153 ml) was added to a stirred solution of *trans*-(4-methoxyphenyl)(4-methylpyrrolidin-3-yl)methanol (Diastereoisomer 2, 0.261 g) and triethylamine (0.510 ml) at  $0^\circ\text{C}$ . The mixture was allowed to warm to ambient temperature and stirred for 16 hours. It was then diluted with DCM (20 ml), washed with water (20 ml), dried over  $\text{MgSO}_4$ , filtered and concentrated *in vacuo*. The residue was purified by flash

30 chromatography using a gradient of 0-70% EtOAc in *iso*-hexanes as eluent, to yield *trans*- [1-

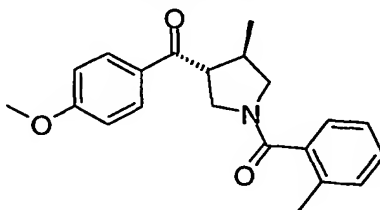
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(4-fluorobenzoyl)-4-methylpyrrolidin-3-yl](4-methoxyphenyl)methanoldiastereoisomer 2 (0.367 g); NMR (DMSO<sub>d</sub><sub>6</sub>): 1.00 (d, 3H), 2.08-2.29 (m, 2H), 3.00-3.17 (m, 1H+H<sub>2</sub>O), 3.32 (m, 1H), 3.57 (br, 1H), 3.73 (s, 3H), 4.04 (m, 1H), 4.48 (br, 1H), 5.03 (br, 1H), 6.85 (m, 2H), 7.11-7.27 (m, 4H), 7.49 (m, 2H); m/z 344.

5

**Example 32**

*trans*- 1-(2-Methylbenzoyl)-3-(4-methoxybenzoyl)-4-methyl pyrrolidine



The procedure described in Example 29 was repeated using *o*-toluoyl chloride and  
10 *trans*-(4-methoxyphenyl)(4-methylpyrrolidin-3-yl)methanol (Diastereoisomer 1) to replace  
the 4-fluorobenzoyl chloride and Diastereoisomer 2 respectively to yield the title compound.  
NMR: mixture of rotamers in a ratio of 1:1, 1.06 (d, 1.5H), 1.17 (d, 1.5H), 2.35 (d, 3H), 2.70  
(m, 1H), 2.90 (m, 0.5H), 3.35-3.52 (m, 2H), 3.64 (m, 1H), 3.76-3.86 (m, 3.5H), 3.97 (m,  
0.5H), 4.15 (m, 0.5H), 6.95 (m, 2H), 7.15-7.29 (m, 4H+CHCl<sub>3</sub>), 7.88 (d, 1H), 7.97 (d, 1H);  
15 m/z 338.

**Preparation of starting materials**

20 The starting materials for the examples above are either commercially available or are  
readily prepared by standard methods from known materials. For example, the following  
procedure is an illustration, but not a limitation, of one of the starting materials used in the  
above Examples.

**25 Method 1****(RS) *N*-Boc-3-(*N*-methyl-*N*-methoxycarbonyl)pyrrolidine**

To a stirred solution of (RS) *N*-Boc pyrrolidine-3-carboxylic acid (9.9g, 46 mmol) in  
DMF (70 ml) was added sequentially 4-dimethylamino pyridine (DMAP, 16.9g, 138 mmol, 3  
eq), *O,N* dimethyl hydroxylamine hydrochloride (6.71g, 69 mmol, 1.5 eq) and EDAC  
30 (11.05g, 57 mmol, 1.25 eq), and the reaction mixture was stirred overnight at ambient

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temperature. The reaction mixture was diluted with EtOAc and the mixture washed sequentially with water (twice), 1M citric acid solution (twice) and brine, then dried and evaporated to give the title compound (9.3g), which was used without further purification.

NMR ( $d_6$ -DMSO): 1.40 (s, 9H), 1.90 (br s, 1H), 2.00 (m, 1H), 3.10 (s, 3H), 3.20 – 3.50 (m, 5H, signals partially obscured by HOD signal), 3.70 (s, 3H).